

Sustainable Street Design:

An Analysis of Best Practices as seen within the Seattle Context

by

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Table of Contents

Executive Summary	3
I. Introduction	
Statement of Purpose	4
Research Methodology	4
Definitions	4
Criteria for Inclusion – Examples of Other Programs and Municipal Undertakings	6
Research Challenges	7
II. Seattle and Sustainable Street Design: An Outline of Current Practices	7
Institutional Commitment to Sustainable Infrastructure	7
Sustainable Street Design, Institutionalized	8
Defining the Need for Updating the Director’s Rule	9
III. Sustainable Street Design: Good for Seattle?	12
Current Seattle Trends	12
IV. Successes To Date and Works in Progress	15
V. An In-Depth Look at the Three Elements of Sustainable Street Design	18
Pedestrian- And Bicycle-Orientation	18
Stormwater Mitigation	24
Green Spaces, including Street Trees and Other Flora	27
VI. North American Examples of Sustainable Street Design	29
Pacific Northwest	29
California	39
West	41
Midwest	41
South	51
East	52
VII. International Examples of Sustainable Street Design	55
Christchurch, New Zealand	55
Europe	56
Denmark	56
Netherlands	57
Sweden	60
Germany	60
The UK	61
Curitiba, Brasil	63
Recommendations	66
Conclusion	67
Appendices	68

EXECUTIVE SUMMARY

The City of Seattle currently has a policy seeking to advance “green” street design. The City’s policy focuses on creating pedestrian-, bicycle- and transit-friendly rights-of-way that also serve as community greenspaces. However, the current policy has a number of shortcomings that serve to limit the breadth of its application. This paper represents an attempt to provide a foundation for improvements to Seattle’s green streets policy, with an eye towards creating a policy that will result in widespread application by both public and private sectors of sustainable street design techniques.

The present policy has numerous shortcomings, including a lack of built-in avenues for interdepartmental collaboration, contradictory guidelines, and insufficient institutional capacity for encouraging and bringing to fruition so-called green streets. This paper lays the groundwork for development of a more complete green streets policy.

The paper is broken into eight sections. First, the paper makes brief explanation of the rationale for its creation, including a definition of sustainable street design (the term this paper uses to replace the current term of “green streets”). The first section also explains the research methodology used on its development, and some of the challenges inherent in such a project. The paper then proceeds to detail the current Seattle situation vis-à-vis sustainable street design, including a description of current City policy, explanation of shortcomings of that policy, and an examination of some of the City’s successes in sustainable street design.

The paper then details the sustainable street design practices of numerous other municipalities, both domestically and internationally. All other municipalities cited in the paper are utilizing some pioneering form of sustainable street design, innovative method for implementation, or novel incentive/regulation responsible for the creation of sustainably designed streets. The descriptions of all other municipalities include a brief section on each particular innovation’s relevance to Seattle.

Finally, the paper concludes with a series of recommendations as to how the Seattle policy and status quo might be improved. This section is followed briefly by a series of appendices, including various matrices of sustainable street design techniques, a detailed breakdown of other municipalities’ programs, and a cost analysis of sustainably designed streets prepared by Seattle Public Utilities.

INTRODUCTION

Seattle currently has a policy that attempts to stimulate creation of “green streets,” but it does not function as hoped. The City would like to update this code to make it more effective and to create incentives to see the implementation of sustainably designed streets actually take place. To justify these changes, the City needs more information about the benefits of sustainable street design, as well as what other jurisdictions are doing to create incentives for their development.

STATEMENT OF PURPOSE

This paper is being undertaken for a number of purposes. It attempts to serve both the academic community and the policy community, and efforts have been made to clearly explain the process and results of the research. It is hoped that this work will be useful in aiding in the development of an appropriate, up-to-date policy on sustainable street design for the City of Seattle.

Specifically, the paper strives to:

- Document sustainable street design in Seattle and identify challenges and opportunities;
- Develop an understanding of sustainable street design, including economic, environmental, and social benefits;
- Outline sustainable street design development in other jurisdictions; and
- Identify actions Seattle can do to encourage/promote sustainable street design.

RESEARCH METHODOLOGY

This paper makes extensive use of interviews and case studies via primary and secondary research methods. Examples of development in other cities cited in this paper have been included based on the potential of their actions being relevant to Seattle; that is, at least some aspect of their design features or processes could be utilized or built upon in Seattle. To accomplish this, the paper will attempt to address the following questions:

1. What makes a sustainably designed street?
2. What are the economic, environmental, and social benefits of sustainable street design in general, and for Seattle specifically?
3. What are other cities doing in terms of sustainable street design? What financial incentives, technical assistance, and regulatory changes are other cities providing to encourage the construction of sustainably designed streets? Do other jurisdictions have established design guidelines for sustainable street design?
4. What are the relative roles for the public and private sectors involved in constructing sustainably designed streets, in terms of development of rights of way vs. the development of private property?
5. In other cities, who designs and constructs sustainably designed street projects? If this is a developer initiative, what kinds of analysis does the permitting jurisdiction require of developers who want to build sustainably designed street projects?

Developing this paper included analysis of local transportation plans, numerous interviews, and extensive online and printed research. Interviews were conducted in person, over the telephone

and via email with city and county officials both domestically and abroad, complemented with online, book and journal research of popular, governmental, and academic resources.

Finally, the various programs and techniques studied were summarized and compared to determine their potential applicability to Seattle, with programs offering unique circumstances featured in the paper and other programs featured, sometimes with less emphasis, in the Program Matrix in Appendix A. In addition, interviews were held with Seattle area transportation officials from various departments and agencies to get a summary of local views on current successes and challenges that remain in creating and implementing the best possible sustainable street design policy. It is worth noting that many places besides those listed herein are also incorporating many of the design elements highlighted in this paper. However, it is the intent of this paper to highlight particularly innovative examples, and to ensure a broad representation of programs. Accordingly, many cities, both domestic and abroad, are doing similar projects to those listed below and have been excluded; this is intentional, but represents no valuation.

DEFINITIONS

Sustainability and the notion of being sustainable have become catch phrases of sorts in recent years, the virtues extolled in myriad industries to sell ideas, products, and methods of production. Until relatively recently, however, finding a common meaning has been somewhat more elusive. Numerous sources now acknowledge the definition of the term “sustainable development” as defined in the 1987 Brundtland Report, which defined sustainable development as, “meeting the needs of the present without compromising the ability of future generations to meet their own needs.”¹ Further, it should be noted that true sustainability engenders not only sustainability of ecological resources, but also economic and social sustainability. Sustainability as it relates to city design, then, must ensure that a city maintains an infrastructure that will provide ongoing, healthy options for its citizenry to work, live and recreate, built upon an infrastructure that will continue to sustain those myriad demands for generations to follow.

Similarly, and perhaps not surprisingly, the definition of the term “sustainable street design” is also not standard. In some instances streets that might be labeled as sustainably designed are called “living streets” or “street yards” and reflecting in their design a desire to put the needs of pedestrians or bicyclists at the same level of importance as the needs of automobiles and their drivers. To others, sustainably designed streets are labeled “green streets,” a reference to their inclusion and heavy use of trees, landscaping, and parks. Finally, sustainable street design can be exemplified by streets that have been engineered to reduce impervious surfaces or that incorporate other design features intended to decrease the amount of stormwater and pollutants that run off the streets and into the public sewer system.

For the purpose of this paper, sustainable street design shall consider all three designations, that is, sustainably designed streets:

1. Are oriented to place pedestrians and cyclists on equal footing with automobiles,
2. Are engineered for stormwater reduction and absorption, and
3. Contain significant greenery in the form of streetscapes and street trees.

¹ The Brundtland Report was published by the United Nations’ Brundtland Commission, and retrieved on 24 Mar 2004 from the Brownfields for Global Learners website: <http://www.brownfield.org/Global/sustainability.htm>.

CRITERIA FOR INCLUSION – EXAMPLES OF OTHER PROGRAMS

This paper lays out a series of examples of sustainable street design techniques and programs that have been or are being developed in other municipalities both domestically and internationally, beginning with a study of current sustainable street design practices in Seattle. The following criteria were considered in determining which municipalities to include as comparisons to Seattle, and all municipalities that have been included fall within at least one criterion. All program or technique descriptions are followed by a paragraph laying out how the situation just described is applicable to Seattle. While efforts were made to specifically research and compare municipalities of approximately the same size, geography and climate as Seattle, other innovative programs or techniques have been included from towns a fraction of the size of Seattle and cities much larger. The inclusion of these municipalities is explained in both the program description and in the subsequent section on the program's applicability to Seattle. Criteria for consideration and inclusion in this paper were as follows:

Applicability

The overriding purpose of this research is to provide a list of sustainable street design techniques and programs that can be used by the City of Seattle to update and improve its street design codes. Hence, it is of utmost importance that all programs considered below be applicable to Seattle, whether topographically, financially, vis-à-vis existing city structure, or in other aspects.

Innovation

Does the municipality have a particularly innovative approach, whether through incentivization, public construction, or regulation? Has the municipality piloted or been working with an entirely new technique or method of developing or increasing some element(s) of sustainable street design? Is the municipality promoting a particularly unique design guideline or program?

Longevity

Sustainable street design is a relatively new concept, and accordingly has very few examples that have been extant for long periods of time. Accordingly, an attempt was made to locate older examples of sustainable street design techniques. Though perhaps not fully as innovative as possible by current standards, these techniques have often stood a longer test of time. In so doing, they can serve as examples and provide insight into the potential sustainability of sustainable street design techniques.

Cost

All examples included in this paper could be accomplished without significant increases in spending on street design and construction. However, it should be noted that in some cases maintenance costs would be higher than in traditional street designs.

Political Feasibility

As with all public works projects, any program or code changes considered for implementation must be politically feasible. Seattle has a strong tradition of environmental activism, as well as a tradition of innovation, which allow it some political flexibility. Elected officials in Seattle have limits, including competing constituency groups (the people to whom the official must answer), time (including both limits on time to focus on a given issue as well as the amount of time an elected official is in office), and bureaucracy (including policies that may contradict new understandings of best practices). Accordingly, the design and technique examples cited in this paper are considered politically feasible.

RESEARCH CHALLENGES

As with any research, the process of developing this paper has been accompanied by a steep learning curve. One of the key elements learned was that, in undertaking an analytical comparison of different programs, one inherently must rely on flawed data. Specifically, for the research undertaken herein, survey results depended in part upon which public official responded to inquiries for interviews. People who chose to speak about their programs undoubtedly had some motivation to do so – perhaps pride in their programs, perhaps an interest in learning about other programs through the conversation, perhaps simply a desire to help a graduate student with his research. However, those who did not speak on their programs likely also had a reason. For instance, other programs might have found their approaches less promising. Regardless of their reason, the lack of information regarding other programs may be a limitation of sorts to the research presented in this paper.

SEATTLE AND SUSTAINABLE STREET DESIGN: AN OUTLINE OF CURRENT PRACTICES

Seattle has taken great strides in recent years to engender the many facets of a sustainable, livable city. Indeed, the city has begun to embrace numerous elements of sustainability, including many perceived suburban qualities – the availability of services and provision of goods necessary for daily life, as well as “privacy, solitude, freedom, quietness, good air, gardens, parks and promenades – without also capturing the “unsustainable characteristics of many...suburbs,” including dependency on automobiles, monotony and sprawl (Frey, 20). This chapter will describe the City’s current initiatives, including its Green Streets policy. It will proceed to discuss obstacles to the policy as currently written, as well as current trends in Seattle street design and successes that have been realized in the City to date.

INSTITUTIONAL COMMITMENT TO SUSTAINABLE INFRASTRUCTURE

Sustainable infrastructure has a decidedly strong presence in Mayor Greg Nickels’ overall agenda, as first seen in the Mayor’s 2002 Environmental Agenda. The Agenda, launched on 22 April (Earth Day) of that year, said: “As we shore up our basic infrastructure and implement our neighborhood plans, we’ll have great opportunities to try some new approaches to design and construction that are smarter, more efficient, more durable, and better for both our communities and the environment.”²

Mayor Nickels has retained his commitment to building a sustainable city infrastructure in the two years since that speech. Indeed, sustainable infrastructure is once again a key element of the Mayor’s environmental platform, as codified in the 2004 Environmental Action Agenda. The Agenda creates an extensive set of objectives, coupled with corresponding indicators/targets, background, and new actions (proposals). While clearly ambitious, this Agenda serves as a basis for the Mayor’s aggressively pro-environment stance, and clearly codifies the City’s intent to pursue sustainable development strategies, both within its operations and through the operations of entities with which it works.

Regarding sustainable street design, the 2004 Agenda lays out a series of different spheres of influence in which the City will strive for environmentally sustainable operations. The first of those is a commitment that the City will lead in “practices that save money and improve the health of people and the environment.” It will design and construct “City facilities that are healthier for people and the environment, and that cost less to own and operate” (Agenda: 1). In this endeavor, the Agenda commits the City to continuous improvement of the city’s overall environmental focus, with a specific focus on Seattle Public Utilities (SPU), Parks, and the Seattle Department of Transportation (SDOT). It also calls for City encouragement to see “major local and regional transportation infrastructure improvements” using “sustainable design and construction practices” (Agenda: 9).

Similarly, the Mayor calls for further preservation, protection and development of the urban forest and open spaces, as well as the protection and restoration of salmon habitat and urban water bodies. This builds upon previous goals, with the 2003 recognition of the City’s

² Nicholas, Steve. “‘Green infrastructure’ puts Seattle on the map.” Seattle Daily Journal of Commerce, 25 July 2002. Retrieved on 10 May 2004 from <http://www.djc.com/news/en/11135643.html>.

acquisition of over 30 acres to be developed into new parks and open spaces.³ The retention of these natural facilities serves to provide not only aesthetic value to the city, but also considerable environmental, health, and economic benefits, as will be discussed at length later in this paper. They also complement another element of the Mayor's Agenda, which is a call to reduce stormwater pollution.

The Mayor's agenda also calls for an increase in open spaces in downtown Seattle, providing increased "community gardening opportunities" as well as making the downtown more pedestrian friendly (Agenda: 4). In addition, the Mayor has committed the City to creating and supporting alternatives to driving alone while concurrently aiming to "make Seattle the most bike- and pedestrian-friendly city in the country" (Agenda: 8).

SUSTAINABLE STREET DESIGN, INSTITUTIONALIZED

Seattle currently has a "Green Streets" program to encourage the development of green spaces and planting of street trees, as defined in the Director's Rule DCLU 11-93/Seattle Engineering Department (SED) Director's Rule 93-4, developed by the SED and the Department of Construction and Land Use (DCLU). According to Lyle Bicknell, SDOT planner, this directive was initially created in part due to recognition that available land for green spaces in downtown Seattle was "minimal at best" and that any land that *was* available was more expensive than the City could reasonably afford.⁴ Thus, Green Streets as envisioned in the planning of the DCLU Rule were to serve as a solution of sorts to the problem of too little green space downtown.

The Green Streets program was created as an update to a 1985 Land Use & Transportation Plan for Downtown Seattle (LUTPDS), which designated a number of streets as street parks. Building upon the LUTPDS, the DCLU's Green Streets designation identified a series of downtown streets (as well as some in the Northgate area of north Seattle) upon which the development of green streets would be encouraged. It proceeded to develop the Director's Rule, which defines green streets as "right-of-way designed to give pedestrians, bicyclists and transit patrons preference over passenger vehicles" that serve "as gathering places or as corridors connecting activity areas and open spaces in an attractive urban setting" (3). The Rule was created to craft a series of policy and technical guidelines that would both define and encourage the construction of green streets, offering a template for developers to use when dealing with the City regarding both permitting and practical elements of green street design.

The Rule does not concern non-arterial, residential urban streets (see map in Appendix B for details). As currently written, the Director's Rule defines four different types of Green Streets, described in the table below.

³ "2003 Environmental Action Agenda Progress Report." City of Seattle Office of Sustainability and Environment, 2003.

⁴ Phone interview with Lyle Bicknell on 20 February 2004.

	Green Streets: Specifications
I	Motorized traffic prohibited with exception of emergency and off-hour service delivery vehicles.
II	Streets necessary for local circulation but not for overall vehicular movement; local access only, with restricted vehicle movement between blocks.
III	Continuous traffic allowed, as well as intra-block traffic. Incorporates widened sidewalks, landscaping, and pedestrian amenities along right-of-way.
IV	Little or no vehicular traffic. Street ends serve as trails or community open spaces/natural areas. Pedestrian malls or natural paths; the streets become parks, destinations in themselves.

Opportunities for green street designs delineated in the Rule are varied, and offer developers a series of elements from which to choose. The Rule proceeds to lay out a number of other design elements that fit under the rubric of Green Streets, including:

- Landscaping elements, including street trees and ground cover
- Design of paving materials
- Special signing
- Street furniture, including benches and newspaper stands/vending carts
- Lighting fixtures
- Fountains
- Recreational equipment
- Litter receptacles
- Bicycle racks
- Public art

The Rule also attempts to explain the process for attaining permitting for, implementing and using any of the aforementioned techniques, including a diagram of the permitting process. In addition, the Director's Rule also incorporates a series of design standards for implementing the Rule. However, as this is a Director's Rule of the DCLU, it does not specify how other City departments will react to and interact with applications for development of Green Streets. Further, and again because of its origination in one department of the City, the Rule does not guarantee cross-departmental support for and permitting of the innovations proscribed by the Rule. The difficulties associated with this situation will be discussed in greater detail below.

DEFINING THE NEED FOR UPDATING THE DIRECTOR'S RULE

Unfortunately, the Director's Rule as it currently stands has significant shortcomings, including a number of contradictions that can actually serve to discourage the development of sustainably designed streets. Foremost among those flaws is the fact, noted above, that the Director's Rule is the policy work of one department and consequently has a limited mandate for implementation. Though it was created through collaboration with SDOT, the two departments have different purview, a situation that limits the Rule's applicability and acceptance. For example, while the rule rests with the DCLU, which is concerned with land use (and ideally would see narrower roads to create more open spaces), SDOT has authority over the public right-of-way, which makes public street safety and capacity its primary concern – and gives rise to its fears that narrowed roads would be less safe and have less capacity. It is not hard to understand the sentiment noted in the Seattle Daily Journal of Commerce that, “while city code requires land

use officials to enforce Green Street guidelines, city transportation officials are understandably resistant to major changes along a perfectly good street.”⁵

Intra-Policy Cohesion and Consistency

A second rather significant flaw is conceptual: while the diagrams for the four street types are clear and provide illustration for Green Street options, they are countered within the same report by the description and graphic image defining minimum right-of-way improvements, including technical specifications for a street. The technical specifications required under this graphic do not coordinate with the possibilities laid out in the Green Street options.

Indeed, there seems to be a broad desire for consistent standards; sustainable street design is an unusual concept, and the experience reported by various developers is that people in the permitting departments often do not know what to do with an application for a Green Street-style development. Those developers report a desire to know up front how things will be done, including acceptable mechanisms and design standards, so as to reduce or eliminate uncertainty from the planning process. In a traditional design, permits may be required from only one Department, which makes the timeline for their acceptance relatively standard. With Green Streets, permits must come from both the DCLU and SDOT, adding a layer of complexity to an already elaborate process.

Complexity of Process and Flexibility of Standards

Interviews with city officials, developers and residents also bring one to the conclusion that the maze of permitting departments and permitting staff through which one must tread to develop a sustainably-designed street is so tedious as to make the projects undesirable. Many of those interviewed commented on the length and complexity of the process of developing streets in compliance with Seattle’s Green Streets directive. While both the DCLU and SDOT express a desire to work with, encourage, and see development of Green Streets, developers also complained of a lack of intradepartmental and interdepartmental consistency, a disconnect between various regulating bodies that results in developers hearing one thing from one body, another from a different one, and something different again upon return to the first.

Further, in recognition that sustainably-designed streets are different from the norm and do not necessarily fall into a traditional master plan for development, city officials and developers interviewed for this paper stressed a strong need for flexibility in development processes. To this end, City officials and developers made clear the need for accurate codification of what street requirements will be on non-standard street designs, including green streets. Developers noted that potential sustainably designed streets could utilize any number of relatively new techniques, adding to the complexity of attaining permits. However, here too, it was felt that a City policy creating a structure for and expectance of flexibility within standards would be of great use.

Indeed, city officials acknowledge that the program has had difficulties since its inception. SDOT, for example, initially blessed the document, Director’s Rule 11-93, upon its creation.

⁵ Gangnes, Drew. “Seattle’s Green Streets ripe for modernization.” Seattle Daily Journal of Commerce. Seattle, Washington. 2 October 2003. Retrieved on 14 May 2004 from <http://www.djc.com/news/co/11149502.html>.

However, according to one city official, SDOT became less forthcoming with endorsements for actual development changes once the directive was actually in place. This may have been an instinctive posture; for several decades, the purpose of SDOT and affiliated entities has been to develop more and greater spaces for automobiles, and the policy changes that resulted in the green street initiative flew directly in the face of those notions. It may also be, as noted above, simply the competing situations of different agencies with different agendas.

Institutional reticence to permitting Green Streets seems to have cemented as time passed, and at some point Seattle found that the “carrots” designed to encourage the desired changes were barely being used, if at all. The City used construction directives such as the FAR (floor area ratio⁶) and residential building requirements as incentives for people to encourage Green Streets, but too often the Green Street options were being ignored in favor of other methods of getting to the incentives. The City has also used the Design Review Program⁷ as a sort of bully pulpit to enforce its agenda, though it is important to note that in the end neither the City nor developers have sway over the right-of-way itself (which, as noted above, is the purvey of SDOT).

According to interviewees in the City, in more recent years the focus has shifted from merely creating more green spaces to improving efficiency and the environmental aspects of rights-of-way. To this end, the City has begun seeking ways to reduce automobile use and its associated deleterious effects, as well as working to reduce stormwater runoff.

Even with this renewed focus, however, the sheer multitude of stakeholders in street design has ensured continuing disagreement over appropriate design. The traditional method of greening streets through adding flora, such as trees, to streetscapes has encountered substantial resistance from utilities, for whom trees present logistical as well as public relations challenges: trees planted along the right-of-way are often directly above utility equipment, and when that equipment has problems, the trees often have to be removed, a situation that causes residents to complain about the utility company. Additionally, the techniques involved in building pervious streets, while well-studied and scientifically supported, have not yet been proven through actual implementation anywhere downtown for fear that the surfaces will not prove durable enough, or that maintenance demands will be too high, to justify their use.

⁶ Floor area ratio is essentially an incentive that allows a developer an additional ratio of floor area in a building relative to the total area of the site. Cities generally have specific regulations concerning floor area ratio, and the incentive in using FAR can be to offer more than the standard ratio.

⁷ Seattle's Design Review Program provides a forum for citizen and developer interaction in developing new construction projects. It uses specific design guidelines to determine necessary site review, design characteristics, design guidelines, and issues of environmental review, and includes a Design Review Board to mediate and assist with construction projects. “Design Review Guidelines,” retrieved on 19 April 2004 from http://www.cityofseattle.net/dclu/publications/Design_Review_Guidelines/.

SUSTAINABLE STREET DESIGN: GOOD FOR SEATTLE?

The green streets concept was developed and still fits into the Seattle ethos of community and environmental responsibility. Indeed, in Seattle's Comprehensive Plan: Toward a Sustainable Seattle, Attachment 1 states that Seattle has four core values: Community, Environmental Stewardship, Economic Opportunity and Security, and Social Equity.⁸ Properly developed, green streets in their various forms embody all four of these values, and are part of a greater commitment to sustainability as evinced in the Comprehensive Plan.

Broad institutional commitment is not the only acknowledgement of these greater goals implicit in the four values. Following up on these four values, the City defines a variety of action steps that will help it to move along the path of sustainability, including the creation and maintenance of "vibrant, pedestrian-oriented commercial areas," "community facilities...within walking distance of the village core," "transit, bicycle and pedestrian facilities with connections to...the village and surrounding neighborhoods," and "well-integrated public open space" (ix).

CURRENT SEATTLE TRENDS

Pedestrian and Bicycle Orientation

Seattle has a reputation as a city of people who love the outdoors and being active. It is perhaps somewhat surprising, then, that a Puget Sound Regional Council (PSRC) report shows the Puget Sound region rates comparably to the national average in terms of trips made by bicycling and walking, with 16% of PSRC residents reporting that they "often bike or walk as part of their regular commute"⁹ (a figure slightly above the national average of 14.2%).¹⁰ The Washington Department of Transportation (WSDOT) reports a 75% increase in bicycle commuting in the state in the past ten years,¹¹ and this statistic seems destined to continue growing as groups like the Cascade Bicycle Club increase their presence and more commuters realize the benefits of commuting by bicycle or walking.¹² However, the PSRC survey also shows Puget Sound citizens with a relatively strong level of dissatisfaction with the current availability of bicycle and pedestrian options.¹³

⁸ "Seattle's Comprehensive Plan: Toward a Sustainable Seattle, A Plan for Managing Growth 1994-2014." City of Seattle Strategic Planning Office. Last amended 25 Nov 1997. P. vi.

⁹ "Regional Bicycle and Pedestrian Implementation Strategy for the Central Puget Sound Region." Seattle: Puget Sound Regional Council, February 2003. P. 9. Retrieved on 10 Apr 2004 from <http://www.psrc.org/projects/nonmotorized/implementation/ch2.pdf>.

¹⁰ "2002 National Survey of Pedestrian and Bicyclist Attitudes and Behaviors." US Department of Transportation's National Highway Traffic Safety Administration (NHTSA) and Bureau of Transportation Statistics. Retrieved on 15 Feb 2004 from http://www.bicyclinginfo.org/insight/fact_sheets/.

¹¹ "Bicycling in Washington." Washington State Department of Transportation. Retrieved on 16 Feb 2004 from <http://www.wsdot.wa.gov/bike/Commuting.htm>.

¹² The Cascade Bicycle Club's Mission Statement includes the goals of getting "more people riding more often more safely" while at the same time promoting bike riding "as a transportation alternative." Retrieved on 16 Feb 2004 from <http://www.cascade.org/about/>.

¹³ The 1999 PSRC survey that showed sixty percent (of respondents) disagreeing with the notion that, 'The region and/or my community is as pedestrian and bicycle-friendly as it should be.' Similarly, two times as many people as not agreed with the statement that 'We should have more walkways, bike lanes, trails and amenities (bike racks on buses and at park-and-ride lots).' "Regional Bicycle and Pedestrian Implementation Strategy for the Central Puget

Interestingly, the complaint that ranked highest as a deterrent to bicycle commuting was ‘unsafe routes,’ a problem that could easily be addressed through sustainable street design principles.¹⁴ The PSRC survey concluded that attitudes exposed “point to public support for more and better walking and bicycling facilities throughout the region and a willingness to use them” (10).

Traffic calming has long been recognized as a key component to making more pedestrian- and bicycle-friendly roads, and to that end Seattle has done considerable work. SDOT reports that, since the creation of Seattle’s Neighborhood Traffic Control Program (NTCP) in 1978, the city has installed over 800 traffic circles on Seattle streets, mostly in residential neighborhoods. The Department notes that the installation of these circles has “resulted in a substantial reduction in accidents and speeds in neighborhoods.”¹⁵ Seattle has also used chicanes¹⁶ (an example of Seattle’s chicanes is shown at right), speed humps, and curb bulbs/bulbouts (in-depth definition and discussion of the various forms of traffic calming and their benefits is found in Appendix C).



Stormwater Mitigation

To date, Seattle Public Utilities (SPU), a department of the City of Seattle, has been at the forefront of developing stormwater management-oriented, sustainably designed streets. Having begun a bold campaign in 2000 to put in place alternative street designs, SPU has developed a trio of streets that utilize a variety of unconventional stormwater management techniques. Located in a variety of Seattle neighborhoods, these streets are thus far being built at the neighborhood block scale. All of the streets use so-called Natural Drainage Systems (NDS) technologies to reduce stormwater volumes, improve water quality, and reduce peak flows while also providing more aesthetically-pleasing neighborhood development that concurrently involves the community, increases pedestrian traffic and traffic safety (through the reduction of car speeds), and reduce the “total life-cycle costs” of stormwater mitigation system.¹⁷

Interestingly, SPU notes that the NDS used thus far actually cost about 10 to 20% less than traditional street development that incorporates “curb, gutter, catch basins, asphalt, and sidewalks.”¹⁸ Given the youth of SPU’s program, they acknowledge uncertainty regarding the long-term results of NDS design on residential streets. Initial results, however, are positive.

Sound Region.” Seattle: Puget Sound Regional Council, February 2003. P. 9. Retrieved on 10 Apr 2004 from <http://www.psrc.org/projects/nonmotorized/implementation/ch2.pdf>.

¹⁴ Unsafe routes were cited ahead of concerns regarding ‘time,’ ‘distance,’ or ‘weather.’

¹⁵ Retrieved on 10 May 2004 from SDOT’s “Neighborhood Traffic Control Program” website: <http://www.ci.seattle.wa.us/transportation/ntcphome.htm>.

¹⁶ Chicanes are a constructed traffic-calming structure in which curb extenders are built on opposite sides of the street, forming a series, typically three, of S-curves. Chicanes slow traffic and can serve as greenscapes.

¹⁷ As opposed to traditional pipe systems, NDS improves with age as plants and trees grow and add to the NDS’ capabilities. Retrieved on 20 April 2004 from: <http://www.seattle.gov/util/naturalsystems/drainagesystems.htm>.

¹⁸ Ibid.

Finally, it is worth noting that SPU offers an incentive for the use of permeable pavings. Specifically, the agency offers an impervious surface reduction credit under the November 2000 Flow Control Manual's stormwater code, a variable credit based on soil percolation rates.

Seattle's "Green" Initiatives - Trees and Other Vegetation

By all accounts, Seattle considers itself a green city. Steeped in the lore of the Olmsted Brothers,¹⁹ Seattle has long planned for and developed its parks – to a point where it now has 2,300 acres of developed landscapes in the parks system, as well as “over 250 acres of specialty gardens, 130 acres of plant beds, and more than 1,800 acres of turf area.”²⁰ Recent trends show a notable decline in the presence of actual greenery, however. A recent study by Noelle Studer reports on the decline of street trees in Seattle,²¹ a trend she blames largely on a City policy that fails to adequately support trees (both financially and through maintenance support) and places responsibility for tree maintenance and care on “abutting property owners,” someone that Studer points out is unlikely to be fully aware of the benefits trees provide (Studer: 2).

Interestingly, Studer also reports that the decrease in tree cover seen in Seattle in the 24 year period reported would yield an estimated 1.2 billion additional cubic feet, or a 29% increase, to the stormwater flow in a peak storm event. To replace that lost capacity with human-made structures would cost \$2.4 billion (based upon estimates of \$2 per cubic foot). Studer draws on the same American Forests study to note that the trees in question would also have removed from the Puget Sound's air a variety of pollutants totaling 35 million pounds, with a value of roughly \$95 million – this from a region that, according to the Puget Sound Clean Air Agency, has a level of “air toxics risks” that ranks it in the top five percent in the nation.”²²

That adjacent property owners are responsible for street tree care adds an additional level of complexity and increases the likelihood that a tree will not receive proper care. Specifically, Studer points out that people “cannot be excluded from enjoying the benefit of individual street trees” and notes that the current system does not include market forces that push citizens to care for trees. Studer also posits that lack of information means many citizens are unaware of their responsibilities and may not know how to properly care for trees and may be unaware of the “punitive consequences” of not caring properly for the trees (Studer: 2). Further, Studer quotes Nolan Rundquist, Arborist for SDOT, as saying, “Seattle residents just don't like big trees” (Studer: 4). Studer attributes this to a public perception that large trees are dangerous, as well as to a general lack of understanding about the benefits of (big) trees. However, public awareness of and concern for street streets is a key component for success with sustainable street design.

The three elements of the program, as well as an example of the original green streets concept, are described below. Additionally, a matrix of costs is included in Appendix D.

¹⁹ The Seattle parks system was largely the design work of John C. Olmsted, son-in-law of Frederick Olmsted, principal of the nation's first landscape architecture firm and designer of Central Park.

²⁰ Retrieved on 15 May 2004 from Seattle Parks and Recreation: <http://www.cityofseattle.net/parks/horticulture/>.

²¹ Studer cites a recent analysis of satellite photos of the Puget Sound, “Regional Ecosystem Analysis Puget Sound Metropolitan Area,” showing high vegetation and tree canopy coverage declining by 37% from 1972 to 1996, with a 50% decrease in Seattle. P. 1.

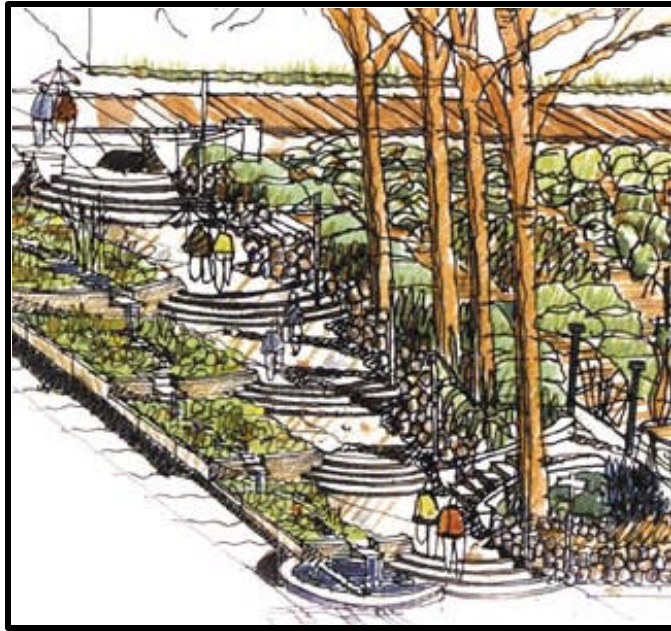
²² Puget Sound Clean Air Agency. “Air Toxics Highlights.” Retrieved on 15 April 2004 from http://www.pscleanair.org/news/other_pubs_toxicsfacts.shtml.

SUCCESSSES TO DATE AND WORKS IN PROGRESS

Despite the challenges facing Seattle's Green Streets policy, a number of projects stand out as examples of the potentials of sustainable street design. While all are either young or still being developed, these streets are nationally recognized as examples of potential changes to come.

Vine Street

The Growing Vine Street project is already quite successful in exemplifying elements of a sustainable street. One of the streets originally designated as a Green street in the DCLU Director's Rule, Vine Street is a downtown street that is still in the process of being redeveloped. To date, it has seen the addition of bioswale-type stormwater management techniques and traffic calming measures. However, even that has not yet achieved the hoped-for potential. The initial vision had hoped for bioswales cleaning Vine Street stormwater to the point that it could be deposited directly into Elliott Bay, but that has not yet happened.



However, according to a city official and developers working closely on the Growing Vine Street project, there is still significant resistance to any untreated water being drained directly into Elliott Bay, making that aspect of Vine Street unlikely to come to fruition any time in the foreseeable future. Other elements of the Growing Vine Street project, including further traffic calming, stormwater mitigation, and pedestrian and bicycle-friendly measures, are still in the development phase, though they show signs of moving ahead. The sketch above, by Carlson Architects, shows a rendition of the envisioned future of the street.

SEA Street

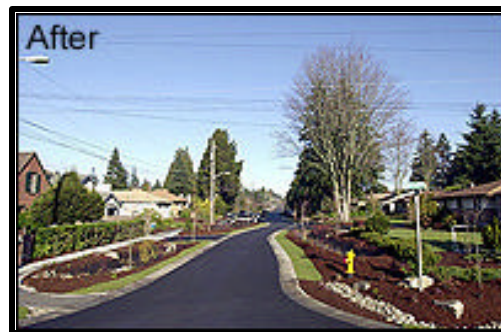
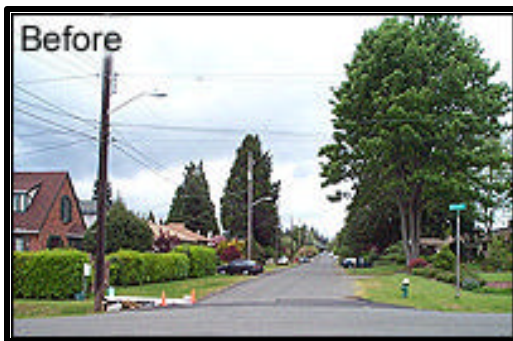
The first of three SPU streets that will be described here, the SEA Street (SEA stands for Street Edge Alternatives), is "an alternative street design that uses grading, soil science, plant selection and non-linear layout to function more like an undeveloped landscape."²³ Located in North Seattle, it was originally built as an attempt to utilize innovative new stormwater management and street design techniques while concurrently managing significant flooding of residential basements. It includes a sidewalk and is constructed to ensure traffic calming.

SPU, which has taken a strong initiative on sustainable street design, reports being able to achieve green benefits at costs approximately comparable to traditional street improvement (involving curb, gutter and sidewalk). SEA Street is a groundbreaking example, unique in the

²³ Retrieved on 21 Mar 2004 from the Seattle Public Utilities website: <http://www.seattle.gov/util/naturalsystems/>.

nation. It includes a narrower driving lane with limited angle parking, at-grade pavement, and rock-lined swales covered with a forest floor-like soil, planted with various native plants, and joined by short lengths of pipe. Preliminary measurements from its first two seasons of existence show a 98% reduction in runoff on the redesigned street.²⁴ Indeed, an article in the Seattle Post-Intelligencer cited analysis by a University of Washington (UW) professor, Richard Horner, who found a change from 5000 cu ft run-off before the street was redesigned to 132 cubic feet of runoff following the redesign, even with an increase from eight to nine inches of rain.²⁵

The design “is ‘the best example right now around Puget Sound,’” said Bruce Wulkan, head of the stormwater program for the state’s Puget Sound Water Quality Action Team; it seems also to be exemplary on a regional and national scale.²⁶ The street, both before and after its transformation, is below.



110th Cascade (Carkeek Cascade)

In a project similar to the SEA Street but smaller in scale, SPU partnered with the Seattle Department of Transportation (SDOT) to implement natural drainage methodologies in an already-developed area. Working in the residential Greenwood neighborhood of north Seattle, SPU and SDOT replaced a ditch and culvert system with a four-block series of “stair-stepped natural pools.” These pools, similar to the SEA Street, slow stormwater runoff, reducing flooding and capturing pollutants. They are complemented by a swale on one side of the roadway, with a variety of trees and shrubs helping to clean and manage stormwater. The project was completed in 2003 and is being monitored by SPU.

High Point

SPU has also partnered with the Seattle Housing Authority (SHA) as it redevelops the High Point housing project. SPU has been working on integrating a natural drainage system into this 129-acre development, a 34-block project that is approximately 10% of a local priority watershed (designated as a priority based on its role as a salmon stream). Similar to the SEA Street, the High Point natural drainage system will incorporate swales into the rights-of-way. These swales will include “sub-surface engineered soil to provide storage and infiltration opportunities,” with

²⁴ Taus, Margaret. “Innovative Design Cuts Street Runoff,” *Seattle Post-Intelligencer*. Retrieved from http://seattlepi.nwsource.com/local/95881_model20.shtml?searchpagefrom=1&searchdiff=432 27 Jan 2004.

²⁵ Ibid.

²⁶ Ibid.

each swale expected to treat both road and housing runoff in their respective area. SPU envisions these swales having a capacity for providing “water quality treatment for the 6-month storm,” with a capacity to provide conditions similar to the area prior to its development in managing a 24-hour storm. Construction on this project is estimated to end in 2008, and researchers from the UW will be monitoring performance of the swales in an on-going capacity.

Broadview Green Grid Project

At 15 city blocks, the Broadview Green Grid Project is the most ambitious of the SPU natural drainage systems to date. Like the 110th Cascade project, the Broadview Green Grid Project is being developed in partnership with SDOT. Upon completion (currently scheduled for August 2004), it will include a variety of natural drainage systems, including swales, stormwater cascades, ponds, and landscaped areas that will manage stormwater flow from approximately 32 acres.²⁷ The Project will also incorporate traffic calming measures and pedestrian amenities, including chicanes, sidewalk and landscaping. Currently in various stages of construction, the streets in this Project presently range from unmodified to nearly complete.

In the Project’s earlier stages, SPU gave residents access to the landscape architect in charge of the Project, making her available for half-hour consultations to ensure neighborhood satisfaction with the proposed changes. Further along in the project, SPU gave residents time to determine whether selected locations were satisfactory for tree planting. The City worked with residents to choose tree location, giving citizens the option of moving trees or selecting an alternate species, in efforts to retain residential views and ensure neighborhood buy-in.

Interestingly, while the Seattle Conservation Corps work crews will check on plants in Broadview’s first year, the City emphasizes in a number of newsletters to neighborhood residents that “planting areas in natural drainage systems are considered to be like any other planting strip or shoulder area in the City, where residents are responsible for maintaining them.”²⁸ Seattle Municipal Code requires all property owners to maintain plantings and sidewalks in front of their homes, but this is generally not enforced; however, Jim Johnson of SPU notes “most people are on some level aware of the law and/or take a certain amount of pride of ownership and want to maintain the street frontage of their house.”²⁹ SPU will maintain the drainage aspects of the system, but aesthetics will be up to residents living near it. The City is encouraging residents to form neighborhood block groups, and to schedule “quarterly work parties” to maintain and care for the swales and vegetation within them,³⁰ something Johnson notes has been occurring with a concurrent rise in neighborhood cohesion as residents participate in the process.

Once completed, it seems likely that the Broadview Green Grid project will set the standard for sustainable street design in this country. Seattle is not, however, alone in its efforts. Cities around the United States and elsewhere are also developing the sustainable street design concept, some innovative examples of which are detailed in sections VI and VII of this paper.

²⁷ Retrieved on 27 April 2004 from SPU’s “The Broadview Green Grid Project” website:
<http://www.ci.seattle.wa.us/util/NaturalSystems/broadview.htm>

²⁸ “Broadview Green Grid: February 2004” newsletter. City of Seattle, SPU. February 2004. P. 1.

²⁹ Email interview with Jim Johnson on 20 May 2004.

³⁰ “Broadview Green Grid: February 2004” newsletter. City of Seattle, SPU. February 2004. P. 2.

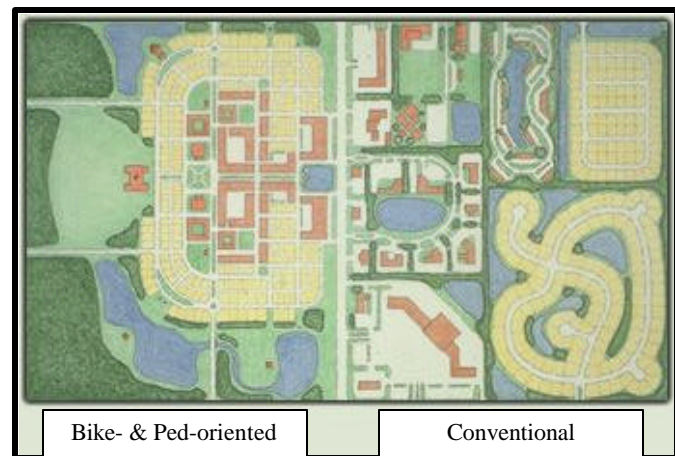
AN IN-DEPTH LOOK AT THE THREE ELEMENTS OF SUSTAINABLE STREET DESIGN

This chapter will make an in-depth analysis of the three main elements of sustainable street design being considered in this paper, pedestrian- and bicycle-orientation, stormwater mitigation, and greenery/streetscapes. It will break each element into sub-categories detailing the benefits of each element, with some further explanation left for the appendices.

PEDESTRIAN- AND BICYCLE-ORIENTATION

Accessibility of streets to bicycle and pedestrian use is a key element of sustainable street design. The use of automobiles is much more difficult in Europe, due to the age of streets (and their often narrow configuration) and greater density of those streets. Some European countries have developed a viable infrastructure for non-motorized transportation. This, in turn, yields numerous benefits including “reduced traffic congestion, roadway costs savings, reduced parking problems and parking facility cost savings, user cost savings, and a variety of social and environmental benefits.”³¹

Streets designed to encourage pedestrian and bicycle use are part of a bigger design picture, related to general development. The illustration at right shows the difference between streets designed to encourage non-motorized traffic and those in more conventional suburban developments. In the left design, the various facets of the community are built within the same area, providing recreational, work, and entertainment opportunities within close proximity to housing. In the conventional diagram, housing is segregated from other uses, a situation that often forces people to drive to their destination, adding to congested roads.



It should be noted at the outset, however, that creating roads that accommodate and encourage bicycling and pedestrians do not, by default, eliminate automobile traffic. Indeed, vehicular traffic not only should not but indeed cannot be eliminated completely, in part because of the need for access by service and emergency vehicles but also because of the strong opposition many people have to giving up owning and using a car (Frey: 43). However, in many instances, particularly in urban settings, sustainable street design dictates incorporating bicycles, pedestrians, public transit and automobiles in a way that slows automobile traffic and allows for safe and efficient use of other forms of transit. Street design that goes to lengths to include bicycles, pedestrians and public transit provide a series of benefits that can be broken down into

³¹ Litman, Todd. “Quantifying the Benefits of Non-Motorized Transport for Achieving TDM Objectives.” Victoria Transport Policy Institute, 1 Dec 1999. Retrieved on 16 Feb 2004 from <http://www.vtpi.org/nmt-tdm.pdf>.

a number of categories, including values to individuals, neighborhoods, communities, schools, and businesses.³²

Safety and Community

Individual citizens stand to see substantial benefits from increased accessibility to streets by bicycles and pedestrians. The psychological and physiological benefits of exercise and fresh air, enhanced public life, socialization of children, creation of safer streets and neighborhoods, and a variety of economic benefits can be accrued at the individual level by pedestrian and bicycle oriented street design.

In Jane Jacobs' 1961 work, "The Death and Life of Great American Cities," she convincingly argues that truly livable cities cannot afford *not* to encourage the proliferation of pedestrians and bicyclists. Jacobs' arguments center around the creation of community and the community's role in providing security to neighborhood inhabitants, particularly in an urban setting. She argues that cities are, by default, composed of strangers with no intrinsic reason, beyond perhaps altruistic human nature, to care for the well being of others. Indeed, Jacobs explains, a well-used street will more likely be safe. To bolster that, she provides substantial anecdotal evidence of the benefit of streets that encourage and thus support flourishing non-vehicular traffic.

Streets that are more pedestrian-oriented tend to attract stores, bars, and restaurants that, in turn, attract more pedestrians. The reduced auto use and resultant increase in economic activity stimulate local employment and provide jobs within the neighborhood. Further, the pedestrians walk or bicycle past places that do not serve the public, such as apartment buildings or warehouses, adding security to those areas as well. People like watching people, and lively streets have both street users and street watchers. The activity and flow of people on pedestrian-oriented streets attracts people, who watch other people from cafes or benches, focusing even more "eyes" on the street. While one could argue that these sets of eyes do not add value to a street, Jacobs argues the contrary. Police alone, she argues, cannot effectively control a community and keep it safe. Rather, heavily-used sidewalks and streetscapes create "natural proprietors of the street," with residents and non-residents forming an informal, unrecognized system of casual public "surveillance and mutual policing," without "hostility or suspicion" that acts as a public control on behavior (Jacobs: 36). The multitude of seemingly trivial interactions that take place on these busy thoroughfares also build a sense of public identity, a "web of public respect and trust" that keeps a street safer and provide a basis for an "assumption of support" when some form of "barbarism" does occur (Jacobs: 56).

Socialization

The community strength and support that accrue on pedestrian-heavy streets are also useful to the greater community beyond those on them at a given time. They also serve as lessons in public responsibility, demonstrating (particularly to children) the public responsibility to others,

³² These categories were taken from a lecture given by Robert Ford, President of Landscape Architects & Planners, Inc., and Rita Wilkerson, Active Community Environments, Governor's Council on Physical Fitness. Presented at the Cool Cities Conference 2003, Lansing, Michigan. Retrieved on 17 Mar 2004 from http://www.michigan.gov/documents/HAL_MCACA_Pedestrian_Friendly_Cities_Ford_83044_7.pdf.

regardless of familial or friendship ties, or formalized responsibility, borne by all city residents. Children learn that the streets and activities that occur upon them are the responsibility of all city dwellers, inculcating in them a similar sense of responsibility.

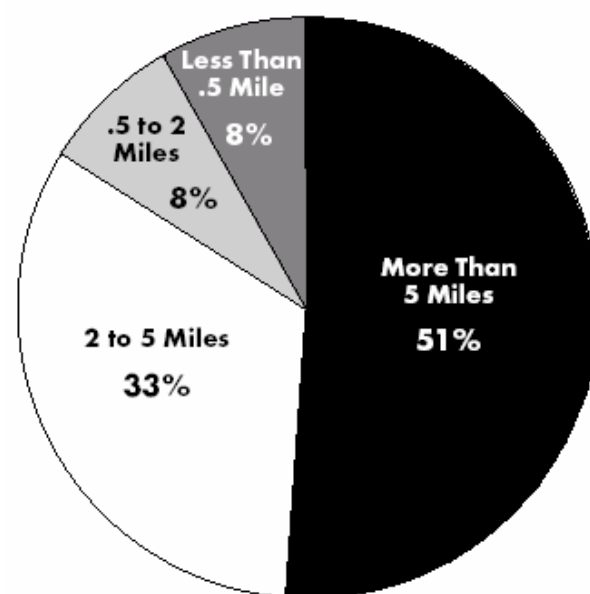
It should also be noted that sidewalk design plays a key role in this paradigm; wide sidewalks, often overlooked as “purely space for pedestrian travel and access to buildings” and not the “uniquely vital and irreplaceable organs of city safety, public life and child rearing that they are,” can accommodate a myriad of functions, from children playing to outdoor cafes to “adult public sidewalk life and loitering” (Jacobs 87). All of these things bring economic vitality, social responsibility, and safety to neighborhoods, particularly in an urban setting where people are, as previously noted, often necessarily strangers.

Personal and Public Economics

Nor is safety the only way in which individuals are benefited by bicycle and pedestrian-oriented streets. In 1997, according to the U.S. Department of Labor, the average household spent approximately 20% of their total annual budget on transportation.³³ In the Puget Sound area, expenditures on transportation were even greater: according to a 1995 Puget Sound Regional Council (PSRC) report, Puget Sound residents spend 25% of their annual personal income on transportation. That number represents a total of \$21 billion in spending on transportation – every year.³⁴

Indeed, that number may even represent a beginning point; according to the PSRC, in 1998 the central Puget Sound region spent \$26 billion on transportation, with \$5400 spent per capita on owning and operating private automobiles, as compared against public expenditures of \$690 per capita on public transit, roads, ferries, and school bus services.³⁵ This spending on automobiles represents a dramatic increase over previous years, and automobile trip statistics suggest that these expenses might be reduced substantially, freeing citizens’ income for other uses, if roads were designed to appeal more to, and were

FIGURE 1: Automobile Trip Lengths in the Central Puget Sound Region



³³ “Issues in Labor Statistics.” U.S. Department of Labor, Bureau of Labor Statistics. Summary 99-9.

³⁴ “The Costs of Transportation: Expenditures on Surface Transportation in the Central Puget Sound Region for 1995.” Puget Sound Regional Council: Seattle, WA, 1996. P. 4.

³⁵ The Puget Sound Regional Council defines the central Puget Sound region as representing the three million people who live in King, Kitsap, Pierce, and Snohomish counties. Transportation spending is defined as spending that covers purchase, maintenance and operation of private vehicles, roads, ferries, and transit service, as well as “conservative estimates of the costs of transportation-related pollution and congestion.” This retrieved on 10 Apr 2004 from the PSRC website: <http://www.psrc.org/datapubs/pubs/briefly/briefly1099.htm>.

consequently used more by, pedestrians and bicycles. Figure 1 shows that 49% of all automobile trips in the Puget Sound region were less than five miles in length, which suggests dramatic potential for increased pedestrian and bicycle transit.

The switch from automobile commuting to bicycling or walking will also result in other economic benefits including, as noted, increased individual spending power. In addition, reduced car use also bears public economic benefits: a recent study indicates that urban peak-period driving costs are anywhere from five to 30 cents per vehicle mile.³⁶ By contrast, switching to non-motorized travel in an urban peak setting has a potential cost savings of 16 cents per mile and is also estimated to provide “congestion reduction benefits worth an estimated 40 cents per urban peak trip (and four cents per off-peak trip).”³⁷

Unsurprisingly, not all costs associated with driving are obvious in simple congestion and fuel costs. In support of the notion that streets should be designed with bicycles and pedestrians in mind, the Victoria Transport Policy Institute (VTPI) argues that bicycling on streets that are not equipped to handle cyclists can actually increase congestion. Their analysis shows that bicycling on uncongested roads, separated paths, congested roads with adequate space for bicyclists (such as shoulders, wide curb lanes or designated bike lanes), or narrow, congested roads with slow car traffic does not significantly contribute, if it does at all, to traffic congestion, whereas on narrow, congested roads with a moderate to high speed of car traffic, bicycles that are unable to keep up with the traffic actually contribute to traffic congestion. The extra delay, in turn, slows traffic, adding to the already well-documented financial burden of congestion and gridlock.

Financial savings can also be realized in roadway and parking costs by encouraging a switch from car to bicycles or walking. The VTPI estimates that the reduced wear and tear on roads of people switching from automotive to non-automotive travel provides savings of ten cents per trip of urban driving (and five cents per trip of rural). Similarly, converting car parking spaces to bicycle lanes and bicycle storage spaces is estimated to have potential cost savings estimated at \$1.50 per urban peak trip, 25 cents for off-peak trips, and five cents for an rural trip, in large part through the fact that as bicycling become a more attractive option and more people bicycle, the number of cars on the road will decrease.³⁸

Bicycling and walking also yield other costs and savings. Bicycles are cheap to own and use, and walking has a “minimal incremental user cost.” The VTPI notes that owners of both a car and a bicycle save the difference in variable costs, while increased bicycle use to the point that fewer cars are need can yield significantly greater cost savings (in vehicle maintenance and insurance, not to mention gas, costs). While a pedestrian does incur greater time costs than one might in using an automobile, *for some trips* bicycles actually compete, and occasionally beat, the door-to-door travel time of cars. However, increased bicycle use and walking represent aerobic exercise, which is also a quantifiable public health benefit.

³⁶ Mohring, Herbert, and Anderson, David. “Congestion Costs and Congestion Pricing,” *Buying Time*.

Minneapolis: Humphrey Institute, 1996. As cited on <http://www.vtppi.org/nmt-tdm.pdf> and retrieved 16 Feb 2004.

³⁷ Litman, Todd. “Quantifying the Benefits of Non-Motorized Transport for Achieving TDM Objectives.” Victoria Transport Policy Institute, 1 Dec 1999. P. 2. Retrieved on 16 Feb 2004 from <http://www.vtppi.org/nmt-tdm.pdf>.

³⁸ Ibid. P. 3.

Public Health

The health benefits of switching from automobile-based transit that can be accrued through the use of sustainable street design features are numerous and varied. First, in the increasingly high-speed global (and American) culture, bicycling and walking as a means of transit offer, in the minds of some, “the only realistic way that the population as a whole can get the daily half hour of moderate exercise which is the minimum level needed to keep reasonably fit.”³⁹ Indeed, the VTPI cites one study noting “heart disease would decline 5-10% if one-third of short trips shifted from driving to bicycling.”⁴⁰ Walking and bicycling can be part of a healthier lifestyle, helping people burn calories while reducing their serving as a healthy form of diversion and reducing their transportation impacts on the environment.

Transit

In addition, consideration should be given for the implementation of transit-oriented development. A relatively new concept, transit-oriented development (TOD) is a term applied to development “centered around and coordinated with a transit station in its use and design,” with the objective of encouraging use of transit (to the discouragement of automobile use). These developments are often mixed use, with compact development located in close proximity to mass public transit, pedestrian-friendly design features, and are developed in such a way as to be community gathering areas.⁴¹

Traffic Calming

Traffic calming can be thought of as a series of mostly structural changes to roads that serve to lessen the “negative effects of motor vehicle use” while improving the situation for other, non-motorized users of the street. Though the term can also be applied to techniques developed “to educated the public and provide awareness of unsafe driver behavior,” only the former definition shall be used for the purposes of this paper.⁴² Implementation of traffic calming measures has increased significantly in recent years in response to dissatisfaction with “vehicle noise, speed, cut-through traffic, exhaust emissions, and traffic-induced vibrations.”⁴³

A number of traffic calming measures are currently in use throughout the United States and Europe, with use spreading greatly in the United States in the 1990s. Simply put, traffic calming is a way to improve street safety and livability through a variety of different methods: vertical deflections (such as speed bumps, raised intersections or speed tables), horizontal shifts

³⁹ “More People, More Active, More Often,” Physical Activity Task Force. London: UK Department of Health, 1995. As retrieved on 10 Apr 2004 from <http://www.vtpi.org/nmt-tdm.pdf>.

⁴⁰ “Bike for your Life.” London: Bicycle Association & Cyclists’ Public Affairs Group, 1995. As retrieved on 10 Apr from <http://www.vtpi.org/nmt-tdm.pdf>.

⁴¹ Retrieved on 20 Mar 2004 from the Seattle Department of Transportation website, Policy, Planning, & Major Projects, Station Planning – Transit-Oriented Development Case Studies: http://www.ci.seattle.wa.us/transportation/ppmp_sap_todstudies.htm

⁴² Retrieved on 25 Feb 2004 from the US Department of Transportation, Federal Highway Administration’s Traffic Calming page: <http://www.fhwa.dot.gov/environment/tcalm/index.htm>

⁴³ Retrieved on 20 Mar 2004 from the Washington, D.C. Department of Transportation website: http://www.ddot.dc.gov/ddot/frames.asp?doc=/ddot/lib/ddot/services/pdf/draft_p11_14.pdf&open=32397.

(including traffic circles and chicanes),⁴⁴ alteration of street alignment, installation of barriers, roadway narrowings including chokers⁴⁵ and center island narrowing), and street closures. Traffic calming can be used to accomplish a number of goals, including reducing crime,⁴⁶ improving safety and enhancing the street environment for “non-motorized users,”⁴⁷ and reducing cut through traffic. As previously noted, various forms of traffic calming are described in Appendix C.

Woonerven

“Woonerven” is the plural form of woonerf, a Dutch concept developed 25 years ago that, literally translated, means “living yard”⁴⁸ or “street for living.”⁴⁹ Woonerven are generally understood to be areas that are designed with both pedestrians and vehicles in mind. In fact, in woonerven design pedestrians enjoy the full right-of-way while cars are forced to slow to a walking pace. This is accomplished in part by a narrowing of the road, often with the presence of planters, benches, parking bays, other obstacles, as well as through a lack of road or footway markings or height differentiations that would force a segregation of vehicles and pedestrians. Woonerven also make use of a variety of paving materials, including paving stones, bricks, or permeable paving.

The concept of woonerven was developed in the Netherlands, but it has now spread widely in Europe. Germany, Denmark, and the United Kingdom have all implemented some form of woonerven-like design as one of a variety of traffic calming measures. In places where they have been implemented, traffic-related accidents have seen dramatic reductions: a 50% reduction in the Netherlands and 20% reduction in Germany (including 50% fewer severe accidents).⁵⁰

The San Francisco Bicycle Advisory Committee reports that woonerven have strict design requirements that make them expensive to construct. They further acknowledge that woonerven are best suited for streets with a low traffic volume. According to EcoCity Cleveland, the cost of retrofitting a street to create a woonerf “may be quite high,” but construction of a woonerf in

⁴⁴ According to the Institute of Transportation Engineers, chicanes are road narrowings or curb extensions on alternating sides of the street, essentially forming S-shaped curves. These devices, also called staggers, twists, deviations, serpentines and reversing curves, are already in use in Seattle, and according to the ITE, are most effective in midblock locations that have “equivalent volumes” of traffic from both directions. Retrieved on 26 Feb 2004 from the ITE website: <http://www.ite.org/traffic/chicane.htm>

⁴⁵ The US Department of Transportation, Federal Highway Administration defines chokers, also called bulbouts or neckdowns, as “curb extensions at intersections that reduce curb-to-curb roadway travel lane widths.” Retrieved on 27 Feb 2004 from <http://www.fhwa.dot.gov/environment/tcalm/part2.htm>.

⁴⁶ Retrieved on 17 Feb 2004 from the Institute of Transportation Engineers’ “Traffic Calming...for Communities” website: <http://www.ite.org/traffic/tcdevices.htm>

⁴⁷ Retrieved on 27 Feb 2004 from the US Department of Transportation, Federal Highway Administration’s General Objectives of Traffic Calming website: <http://www.fhwa.dot.gov/environment/tcalm/part1.htm>

⁴⁸ Bicycle Plan – Part 6: Traffic Calming. Retrieved on 25 Feb 2004 from the San Francisco Bicycle Advisory Committee website: http://www.ci.sf.ca.us/site/bac_page.asp?id=11544

⁴⁹ Retrieved on 25 Feb 2004 from the “Walkinginfo.org” website: http://www.walkinginfo.org/de/curbl.cfm?codename=32d&CM_maingroup=Traffic%20Calming

⁵⁰ C. Hass-Klau. *The Pedestrian and City Traffic*. London, UK: Belhaven Press. 1990. P. 223.

original development would not result in *any* extra cost.⁵¹ This group also specifies that woonerf are best suited for primarily local-access residential streets with low traffic volumes (that is, traffic volumes below 1000 average trips per day). Further, they note that woonerf are useful in neighborhoods wishing to create a “public space for social activities and play.”⁵²

It should be noted that woonerven, like any street design technique, are not perfect. Some limitations include the problem of too many parked cars (and the resulting reduction of open space), difficulty in emergency and service vehicle access, and public acceptance of the concept. In addition, as noted above, woonerven can cost more to build, and will require some additional maintenance.

STORMWATER MITIGATION

The high number of impermeable surfaces in urban areas, including Seattle (in which, according to SPU, 25% of all available land is covered in streets⁵³), often means that stormwater which would normally be absorbed into the ground is instead collected into and funneled through streets, adding to already overburdened sewage systems. In the process, the water picks up a variety of pollutants, including chemicals, fertilizers, oil and gasoline, pesticides, heavy metals⁵⁴ and other trash. Those pollutants, in turn, flow into water treatment facilities and into rivers, lakes, and in Seattle’s case, into the Puget Sound, creating serious water quality problems. All of the pollutants listed can have serious toxicological effects on fish and other aquatic life, as well as damaging spawning areas. Polluted water also makes fisheries unsafe, a problem seen with increasing regularity in the Puget Sound. Indeed, “urban and suburban runoff today is the single biggest source of water pollution” and limits usage of one third of American waterways.⁵⁵

In addition to pollutants, the significant quantities of stormwater runoff also carry high levels of nitrogen and phosphorus. These nutrients lead to excess growth of phytoplankton and zooplankton, which in turn decreases the amount of oxygen available for other species, further damaging fish stocks and other aquatic life. The resulting eutrophication, as has been seen in recent years in the Lake Washington Ship Canal, reduces viable habitat options for fish stock, which also reduces the amount of fish available for recreational fishing and eating. Accordingly, efforts to reduce stormwater runoff would lead to improved health for aquatic species, buttressing the Puget Sound ecosystem against further damage.

The EPA suggests a number of alternatives for reducing the quantities of pollutants entering streams and other water bodies. Besides avoiding the discharge of pollutant-laden substances into such water bodies, the EPA suggests planting around runoff-prone areas, including areas

⁵¹ EcoCity Cleveland is a nonprofit environmental planning organization. Retrieved on 25 Feb 2004 from the “EcoCity Cleveland: Transportation Choices” webpage:

<http://www.ecocitycleveland.org/transportation/traffic/tools/woonerf.html>

⁵² Ibid.

⁵³ Retrieved on 27 Apr 2004 from the SPU “Natural Drainage Systems Overview” webpage:

<http://www.ci.seattle.wa.us/util/NaturalSystems/overview.htm>

⁵⁴ US Environmental Protection Agency, per a NEPA Call-In sheet retrieved on 15 Mar 2004 from

http://hydra.gsa.gov/pbs/pt/call-in/factsheet/1198/11_98_10.htm

⁵⁵ National Water Quality Inventory. 1988 Report to Congress. US Government Printing Office, Washington, D.C. 1988.

subject to high levels of erosion. Tourbier writes that vegetation is the best way to effectively control pollutants in runoff, with plants slowing water flows, collecting sedimentation, removing nitrogen and phosphorus, and encouraging infiltration.⁵⁶

Hazards of Urban Runoff

As noted above, urban runoff commonly contains heavy metals such as lead, mercury, and zinc, which can prove toxic to fish and other aquatic life.⁵⁷ In fact, urban runoff has been blamed for a substantial proportion of the degradation found in American lakes, rivers and wetlands. In fact, a 1992 EPA report credited urban runoff with “an estimated 18% of impaired river miles, 34% of impaired lake acres, and 62% of impaired estuary square miles.” These numbers are especially affecting if one takes into account that urban population centers account for only 2.5% of available land surface in the United States.⁵⁸

A Brief History of Stormwater Management

In beginning to think about methods for improving stormwater management techniques, it is useful to have some understanding about the background of stormwater management, and how it became the responsibility of municipalities. Stormwater management began following the so-called “common enemy rule,” which called for the drainage of runoff away from one’s houses as quickly as possible. With the growth and urbanization of the population, the “common enemy” rule ceased to be as useful, with the yard of one house often serving as boundary and yard to the property of another. Runoff would accumulate and the resulting quantities of water could lead to flood problems.

Historically, stormwater management and flood control was the purview of the federal government. In that time, however, stormwater runoff grew to contain increasing amounts of pollution, to the extent that at one point the “first flush of urban runoff from... Washington, D.C., was found to be as polluted as raw sewage.”⁵⁹ As awareness of the dangers of stormwater runoff grew, the federal government switched to a role of rule-maker and enforcer, passing authority to local municipalities. In 1992, the EPA declared that henceforth construction sites of five or more acres would require a National Pollutant Discharge Elimination System permit, a requirement that further placed a special emphasis on sites of high or exceptional quality. Further, the regulation left responsibility for implementation to local municipalities, who could employ stormwater management plans specific to their location.

⁵⁶ Tourbier, J. Toby. “Open space through stormwater management: helping to structure growth on the urban fringe.” *Journal of Soil and Water Conservation*, Jan-Feb 1994. V49, N1. Pages 14-22.

⁵⁷ US Environmental Protection Agency, per a NEPA Call-In sheet retrieved on 15 Mar 2004 from http://hydra.gsa.gov/pbs/pt/call-in/factsheet/1198/11_98_10.htm

⁵⁸ “Environmental Impacts of Stormwater Discharges.” *The Volunteer Monitor*. V7, N2. Fall 1995. Retrieved from <http://www.epa.gov/volunteer/fall95/urbwat09.htm> on 9 Feb 2004.

⁵⁹ Tourbier. P. 14.

Alternative Ideas About Stormwater Management

Various municipalities have developed unique methods for managing stormwater. Some of the main methods for more sustainable stormwater mitigation are detailed below; further details can be found in Appendix D.

Permeability and Pervious Paving

According to the American Planning Association, any material preventing water infiltration into the soil can be considered an impervious surface.⁶⁰ This definition includes not only roads and sidewalks, but also roofs, patios, compacted soil, and natural landscape features, such as bedrock outcrops. Though humans have created roads and roofs for generations, the impermeable surfaces being used in today's paving are a relatively recent development, a fact that can be seen in a 1904 road census showing 93% of American roads to be unpaved. Not surprisingly, the triumph of the automobile industry over rail travel has seen a drastic increase in the quantity of impervious surfaces in the United States. The advent of permeable paving and encouragement of retaining a large degree of pervious surfaces will prove key to reducing stormwater run-off, increasing groundwater recharge, and encouraging the natural filtration of water. More on pervious paving can be found in Appendix E.

Conveyance controls

Conveyance controls refer to methods of reducing the amount of stormwater entering the sewer pipe system, and consequently to reducing the quantity of water that ends up being discharged. Exfiltration and swales are two methods of conveyance control being used successfully by numerous municipalities around the world.

The city of Toronto, Ontario, currently uses an exfiltration system as a form of conveyance control. In this method, intentionally leaky pipes allow stormwater to leak out and into the ground, where it can be absorbed and filtered before reentering the water table. To ensure filtration, sewer pipes are surrounded by porous materials such as gravel, which in turn allows any remaining stormwater to re-enter the pipes and be filtered as normal.⁶¹

Swales

As noted above, vegetation is the best method for controlling stormwater runoff. Swales, also called bioswales, are intentional constructions designed to "mimic naturally occurring wetlands," utilizing the natural abilities of vegetation for stormwater management.⁶² Swales essentially function much as a natural marsh to filter pollutants: particulates settle in the vegetation and in the "subsurface zone," reducing at the same time the velocity and volume of the runoff. Runoff not captured by the swales continues on to the storm sewer system via an outlet at the end of the

⁶⁰ Arnold Jr., Chester L., and Gibbons, James C. "Impervious surface coverage: the emergence of a key environmental indicator." *Journal of the American Planning Association*, Spring 1996, V62, N2. P. 243 – 259.

⁶¹ Retrieved on 15 Feb 2004 from "Toronto's Water Pollution Solution...Our 25-year plan:"

http://www.city.toronto.on.ca/water/protecting_quality/wwfmmp/25year_plan.htm.

⁶² "Chester County Storm Water BMP Tour Guide." Chester County Conservation District, PA. Spring 2002.

swale. Additionally, some swales utilize series of mini dams to further slow water flow, ensuring that greater quantities of stormwater runoff are absorbed into the ground and creating a “mini-storage” effect.’⁶³

Vegetative swales have become more common in recent years. While not necessarily appropriate for congested downtown streets, swales are increasingly being utilized as a “stormwater best management practice (BMP)” to help reduce runoff and to improve the water quality of that runoff.⁶⁴ Swales have been shown to be cost-effective⁶⁵ tools for stormwater management, and reportedly have relatively low maintenance requirements, including occasional mowing, inspection and the refilling of any eroded paths.

French drains

French drains are drainage systems that do not have pipes for outflow. In a French drain, water collects at or just below the surface in channels that have been filled with gravel or stone. These permeable materials allow the water to percolate into the ground, reducing stormwater runoff and recharging groundwater.

GREEN SPACES, INCLUDING STREET TREES AND OTHER FLORA

Open spaces and vegetation in the form of green wedges and woodland parks add myriad benefits. In addition to the stormwater mitigation benefits alluded to above, green spaces serve as “urban lungs,” provide “interaction of urban and natural processes,” help modify local climate, serve as “outdoor laboratories for teaching forestation,” provide recreational space and serve as an integral connection for urban dwellers to the natural world.⁶⁶

Stormwater Mitigation

As noted, trees serve an important role in stormwater mitigation. In terms of actual mechanics, the initial role of trees is to delay the amount of water that reaches the ground below, with rain collecting on trees and leaves before continuing down or re-evaporating. Water that does continue its downward journey has been slowed, and accordingly the speed with which that now-decreased stream of water continues into streams, the Sound and sewers, decreases. Further, the ground from which trees grow serves as an additional semi-permeable⁶⁷ conduit for water to enter, filtering directly into the groundwater supply.

Air Quality and Health

Street trees and other vegetation also serve to improve air quality. As noted above, trees and other vegetation remove significant amounts of various pollutants, specifically nitrogen dioxide

⁶³ Shaw, L. Yu, et al. “Field Test of Grassed-Swale Performance in Removing Runoff Pollution.” American Journal of Water Resources Planning and Management. May/Jun 2001. P. 168.

⁶⁴ Shaw, et al. P. 168.

⁶⁵ Swale construction costs are estimated at \$5 to \$15 per linear foot (Patron 1998).

⁶⁶ Frey. P. 30.

⁶⁷ Ground around street trees is often compacted, causing it to act as a permeable or semi-permeable surface.

(NO₂, sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), and particulate matter 10 microns (PM10) or less.⁶⁸

The City of Seattle has a Master Street Tree Plan, begun in 1990 and implemented in 1999. This plan has inventoried city trees along all improved City streets,⁶⁹ has determined a list of priorities for planting and maintaining trees, and has proscribed bold new goals to “increase Seattle’s tree canopy, to a total of 40%,” from 27%.⁷⁰

Nor is Seattle alone in calling for the installation of more urban greenery. In 2003, seeking Congressional funding for urban and community forest programs, the United States Conference of Mayors released a statement cataloguing the benefits of urban flora in their communities. Their declaration begins with the principle that, “the vitality of communities is strongly dependent on the quality...parks, tree cover, streetscapes and other green open space.” The Mayoral declaration acknowledges the economic, ecological and social benefits of trees and “associated green infrastructure.” These benefits include, among other things, pollution and stormwater runoff reduction, energy conservation, increased property values, crime reduction, increases in socialization, improved mental states of residents and the promotion of a sense of community.⁷¹ Interestingly, greenery on city streets may also act, indirectly, to cut crime. Green spaces and trees attract people, bringing them outdoors and into community space. As noted by Jane Jacobs, these people become a collective set of eyes focused on the community, discouraging crime.

⁶⁸ Indeed, Studer reports, one 40-year-old oak tree can take 2.4 lbs of toxic substances from the air annually, with Seattle neighborhood trees currently removing 42,365 lbs of pollutants every year.

⁶⁹ “Improved” streets are those with sidewalks and drainage systems. Retrieved on 16 Feb from the City of Seattle Master Street Tree Plan: <http://www.ci.seattle.wa.us/transportation/mastertreeplan.htm>

⁷⁰ Ibid.

⁷¹ “Resolutions Adopted at the 70th Annual Conference of Mayors.” Madison, WI, 14-18 Jun 2002. Page 10. Retrieved on 22 Feb 2004 from http://www.usmayors.org/uscm/resolutions/70th_conference/2002resolutions.pdf.

NORTH AMERICAN EXAMPLES OF SUSTAINABLE STREET DESIGN

This section focuses on sustainable street design as it is being envisioned and implemented across the United States and around the world. The chapter is divided by North American geographic region, and includes Canadian cities intermingled with American municipalities. Each example represents some innovative element, technique or policy of sustainable street design. A section on each element's relevance to Seattle is included at the end of each municipality's description.

PACIFIC NORTHWEST

King County, WA

King County currently has three demonstration projects under development. At the time of this writing, none are under construction, but all are in permit review. The projects each reflect a different approach, and incorporate different design techniques. The three projects are detailed in the matrix below:

Name and Location	Design Techniques Used
Greenbridge in White Center	<ul style="list-style-type: none">• 100-acre, 1100-unit redevelopment of existing public housing• Swales, sidewalk on sides – similar to SEA street
Shamrock development - eastern KC, north of Renton	<ul style="list-style-type: none">• 25-acre, 100-lot subdivision• Two focuses for stormwater management:• Some conventional stormwater management• Some emphasis on conveyance and open bioswales & bioretention
Sunflower – on Vashon Island	<ul style="list-style-type: none">• 4-acres, 14-lot development• Small, but heavy use of LID techniques:• Forest retention, pervious pavement, narrower roads, no curb & gutter, minimizing impermeable surfaces, on-site bioretention of all stormwater

In addition to these developments, according to Steve Foley, an engineer in the County's Water and Land Resources Division, the County is currently in the process of revising its stormwater code to require more low-impact best-management practices (BMPs), though those currently do not, by themselves, impact road standards.⁷²

Foley reports that the demonstration projects have been enabled through ordinance. Specifically, the King County Executive has supported the development of these innovative projects, after which the County Council has given approval for their implementation. Developers to date are constructing them on a voluntary basis, with King County providing technical support but no

⁷² Phone interview with Steve Foley on 22 Mar 2004.

specific financial incentives. The County sees sustainable infrastructure as part of a greater initiative upon which it has been working, the encouragement of “green” building in general.

According to Foley, the developers involved in these pilot projects are generally people who want to “do the right thing,” developing in an environmental friendly way. Foley acknowledged, too, that value is to be had from the public recognition and marketing aspects of developing a “green” project, including the infrastructural elements of sustainable street design.

The King County Roads Division has also done some work evaluating opportunities for using recycled products in road construction and maintenance. Specifically, the County has done some evaluative work on “glasscrete,” “glasphalt,” and “gravel-base” roadbed aggregates with recycled glass or concrete, as permitted by revised WSDOT standards, but their research to date have not indicated practicable applications for the Roads Division. According to Eric Nelson, Environmental Purchasing Program Manager with King County’s Procurement Services Division, the County began trying to help find uses for recycled materials in the early-1990s. Regarding street design specifically, the County has evaluated applications for recycled asphalt, concrete, and glass. However, due to technical requirements and regulatory standards, the use of these new commodities in road construction is permitted only in limited applications, including shoulder ballast (where, in Nelson’s words, “performance is acceptable but availability is not”), and for pipe bedding (in which consistent supply is lacking).⁷³

The County has also made use of sustainable street design techniques at their Metro Van Distribution Center. The Center, a 10-acre site in Redmond, Washington, utilizes biofiltration swales, infiltration trenches and detention ponds. According to SvR, the design company responsible for the development, the facility also incorporates water-efficient plantings.⁷⁴ Finally, the village of Juanita, an eastern suburb of Seattle located to the north of Bellevue, Washington, has recently experienced a transition of sorts – and in an unusual manner. Forced by city regulations to redevelop a suburban “superblock” to create a view corridor, developers created a “multi-purpose street” that concurrently removed the negative “superblock” elements and created a new high-density mixed-use neighborhood.⁷⁵ Of particular interest with this development is that the street, which provides normal vehicular traffic as well as pedestrian spaces, traffic calming, and a gathering space, is privately owned and maintained (but maintained as available for public use through a public easement).⁷⁶

Obstacles

Foley noted a series of obstacles in developing these pilot projects, many of which are similar to some of the challenges Seattle has seen in encouraging implementation of green streets. Specifically, varying from road standards, doing drainage design and providing analysis to show convincingly that innovative new techniques will work and still meet the intent of the drainage

⁷³ According to Mr. Nelson, when a pipe is laid, a material must be placed underneath it that can support the pipe but that is also fre draining so that the pipe does not sit in water. Taken from a phone conversation on 22 Mar 2004 and email conversation on 20 May 2004.

⁷⁴ Retrieved on 20 Mar 2004 from <http://www.svrdesign.com/projects/public/king.html>.

⁷⁵ Oakrock, Barbara. “The street becomes a stage: New roles for roads.” Seattle Daily Journal of Commerce. Seattle, Washington. 18 Apr 2002. Retrieved on 15 May 2004 from <http://www.djc.com/news/en/11132534.html>.

⁷⁶ Ibid.

standards has been challenging. In addition, Foley noted, people involved in these projects are breaking new ground and pushing established standards, so there is a learning process for everyone involved.

One obstacle cited by Nelson was a problem of availability: recycled glass is hard to find in quantities that would be sufficient for County needs, in part because traditional suppliers of sand and gravel have not yet identified sufficient market demand to carry quantities of recycled glass. Suppliers will not likely have such a demand until the material has proven itself in the marketplace as a desirable, as opposed to acceptable, material.⁷⁷

It should be noted, however, that while the current market for recycled glass aggregate is sporadic at best, one local firm has been able to put recycled concrete aggregate into aggregate they are already selling. This, in turn, has lowered their costs for materials and boosted their profit margin.

Relevance to Seattle: Undoubtedly, Seattle is monitoring the results of the King County trials for applicability to Seattle. The City should consider investigating the use of recycled materials in both sidewalk and road construction, to reduce construction costs, to further develop the local market for recyclables, and to add that additional element of sustainability to street design in Seattle. In addition, and as something of a side element of public sustainable street design, the City should consider whether private roads, retained in the public use via easements, might be used to sustainably and economically promote the creation of streets incorporating sustainable street design techniques.

Bellingham, WA

The small city of Bellingham, Washington, has developed an innovative system for managing its stormwater runoff. Titled the Storm and Surfacewater Utility (SSWU), Bellingham is using a utility fund to create a dedicated source of funding for projects to prevent flooding and erosion, and to protect water quality and fish habitat. The fee is charged to residents based on a threshold size (square footage of impermeable surface), with buildings over 3000 square feet (commercial or residential) charged by the square foot of impervious area. Interestingly, the City includes a fee to WSDOT for the section of Interstate 5 that runs through Bellingham.

Relevance to Seattle: Like Maplewood, MN's Environmental Utility Fund (discussed in more detail below), the SSWU could hold great potential for adoption in Seattle. The development of such a fund would create capacity for further innovation in sustainable street design, as well as providing ongoing, designated funding for stormwater mitigation. The fund would complement a renewed policy incorporating technical guidelines, serving as a source of crucial funding.

Vancouver, BC

The city of Vancouver, British Columbia, has undergone a remarkable series of changes in the last few decades, foremost among those a near-complete revitalization of its downtown areas.

⁷⁷ Nelson noted that the glass aggregate has proven acceptable, based on County-sponsored projects, but has not necessarily proven desirable.

Similar to the opportunities faced with the potential redevelopment of the South Lake Union, Waterfront, and South Downtown areas of Seattle, Vancouver chose to redevelop its downtown in a way that created “complete communities,” aiming to attract a diverse group of mixed-income, family and single residents into the downtown.⁷⁸ The creation of “megaprojects,” buildings in which thousands of people would live, in the downtown core has resulted in high-density inner-city living.

Interestingly, none of the development (except public housing) was subsidized, but rather, “growth (was) expected to help pay for growth.” Further, the City required developers of the megaprojects to provide a variety of public goods, including many elements of sustainable street design: “waterfront walkways and roads, parks and marinas,” and other public amenities. As Gordon Price, former Vancouver city councilor noted, “All this makes the developer’s product attractive. Public benefit, in short, adds private value.”⁷⁹

Thirdly, this is not just a city for the rich. Specifically, 20 percent of all units on the megaprojects are reserved for social housing, and 25 percent is designed for families. Reductions in senior-government programs for non-market housing have delayed plans, but sites will be reserved for the time when funding becomes available.

Similarly, Vancouver currently has a number of sustainably designed streets, or streets with elements of sustainable street design, in pilot phases. Interviews with a number of officials within the City of Vancouver, suggest that the biggest challenge facing the City is the question of how to reinvent their streets to be multipurpose, moving away from an ethos with cars as the main focus to one in which the streets add water value, habitat value, are bicycle and pedestrian friendly, and have sufficient parks for all citizens.

It is worth noting that any changes to streets in residential areas in Vancouver require citizen support, specifically two-thirds of residents living in the affected area. Further, non-necessary road improvements are paid for “through a cost-splitting system,” according to City engineer Wally Konowalchuk, in which residents pay their part of the bill on their taxes. The road designs outlined below were largely the result of residents approaching the City asking for alternatives to the traditional stop-gap, asphalt full-road paving.

Stormwater mitigation: To date, Vancouver has made good use of citizen input in developing their various forms of sustainable street designs, and indeed, Konowalchuk notes that the sustainably designed streets Vancouver has “have so far come largely from residential wishes.”⁸⁰ Transportation engineering staff has worked with citizens in developing plans, and they have also made use of citizen labor in constructing the green street pilots. The City is currently experimenting with three types of sustainably designed streets, named “sustainable streets,” “country lanes,” and centre strip design. All are still in pilot or development phases, and considerable trial-and-error seems to be the norm, as in Seattle. Further, funding and long-term

⁷⁸ Price, Gordon. “Is Seattle ready to wear the Vancouver style?” Seattle Daily Journal of Commerce. Seattle, Washington. 2 Oct 2003. Retrieved on 24 Mar 2004 from <http://www.djc.com/news/co/11149498.html>.

⁷⁹ Ibid.

⁸⁰ Phone interview with Wally Konowalchuk on 20 Feb 2004.

operations and maintenance concerns will likely dictate the future development of these street types. Descriptions of all three street types are below.

Sustainable streets: These streets have not yet been implemented, but they are being designed with an eye towards reducing stormwater pressure on the storm sewer system. The vision for the so-called sustainable streets entails the construction of streets without curbs or gutters, instead managing stormwater with bioswales, and their consideration is a result of the need to address unfinished streets in and around Vancouver. As noted above, the sustainable streets initiative is largely a result of resident demand: people in undeveloped parts of Vancouver want their streets to be finished (with stormwater devices and sidewalks), and Vancouver, working to be more sustainable, is attempting to develop alternatives to traditional designs. Vancouver cites Seattle's SEA Street pilot project as an example of what they hope to soon replicate, and Vancouver planners are quick to point out that they plan improve upon Seattle's design.

Country Lanes: Vancouver's country lanes are, as their name suggests, structured like two-wheel ruts in old country roads. Originally envisioned in Vancouver neighborhood "Vision Plans," the City has now developed three of these two-wheel paths and reports them well suited for residential lanes and back alleys. The Lanes, also called "solid wheel strip" paving, are designed to provide maximum area for rainwater absorption while still providing a usable driving surface. They also, Vancouver planners note, add "a rural flavor to the neighborhood."

The first country lane in Vancouver was installed in one day as part of a neighborhood/City collaboration aimed as much at creating buy-in and engaging the community in dialogue as developing the lane. The City asked for residents of the selected block to help build the lane, laying pavers, digging, and generally doing physical work. According to Dave Desrochers, the City was surprised by the volunteer turnout, noting that there were twice as many people at the event as the number of houses actually affected by it. He said the peoples' willingness to help would likely apply across cities, building as it did upon a general sentiment that people want to be involved in their communities, want to be part of improving them.

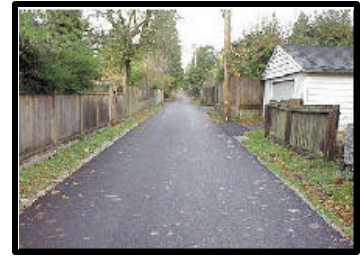
An additional element that has proven useful in Vancouver's efforts to develop country lanes is "structural soil." This product, developed by Vancouver's engineering department, is a new soil that is a mixture of gravel and soil/compost. It will allow plants to grow, but was designed to handle heavy loads such that it will not settle under the weight of cars and trucks.

Vancouver installed the first of the country lane pilots, pictured at right, in late 2002 in a collaborative planning and design effort between city staff and residents. According to Desrochers, Vancouver Street Design Engineer, the three pilots are being monitored on an on-going basis, and will likely be reviewed at the end of this year. If the streets prove successful, the Vancouver Council will likely consider whether to offer the Country Lane as an option in street redevelopment choices available to residents.⁸¹



⁸¹ Phone interview with Dave Desrochers on 23 Mar 2004.

Centre Strip: Vancouver's third method for creating green streets is the so-called centre strip, shown at right. Arguably not as environmentally friendly as the country lane due to its greater use of asphalt and larger impervious area, the centre strip also provides a wider driving surface while still allowing more water to be absorbed into the ground than would occur with a traditional street. The centre strip is a better option than full width paving for residential areas where width demands are less.



Additional Projects: The projects listed above are much publicized, but Vancouver engineers note that the City is also working on a number of other projects. Specifically, they have been working on cache basins with swales on the other side (from the road) of the curb and gutter. The City has also been developing infiltrating cache basins with sumps (as in houses, these sumps have holes that allow fine particles and silt to filter into the ground instead of overflowing into the storm system). Vancouver has also been experimenting with some detention ponds in parks. However, according to Desrochers, most of the projects described above are, like the three main sustainable-designed streets, pilot projects that cost more but “are designed to show people what can be done.” Additionally, Desrochers added that a challenge in getting non-City entities to develop more sustainable streets has to do with uncertainty in permitting departments surrounding new, potentially risky technologies. He suggested that changes in the permitting process such that “people doing the right thing can get permits faster” might be a potential solution to this problem.

Relevance to Seattle: The cities of Vancouver and Seattle have similar climates, making comparisons more appropriate than in many cases. The country lanes and centre strip options would likely work well in Seattle alleys, and Seattle should strive to emulate Vancouver's country lanes in alleys throughout the city. Though alley improvements are currently outside the purview of the City, this could prove another example in which, like SEA Street, the City could develop an innovative new technique, which would then lead to considerable local interest and subsequent adoption by neighborhood improvement groups and developers, offering still another alternative for developers wishing to reduce/offset impervious surfaces. Widespread adoption would substantially reduce the amount of water entering the city's treatment system, cutting operating costs and reducing stress on infrastructure as well as the Puget Sound. Alternately, the City's neighborhood matching grants program could see citizen labor and energy used to create the Country Lanes, providing materials and expertise while utilizing the voluntary labor of neighborhood workers.

Taken from a bigger perspective, Vancouver has a good deal to offer Seattle. Specifically, as cities of similar size, resources, climate, and topography, the two Cities should work together as much as possible. Continued intra-City collaboration, already recently begun, could be of great benefit to both Cities, with significant potential for collaboration and learning from one another's successes and challenges. The two Cities, along with Portland, are already developing a network of communications, including developing a website, for exchanging ideas, best practices, and information; this process will be key to creating and maintaining a strong foundation for ongoing collaboration.

Victoria, BC

Victoria has taken a relatively hands-off, yet creative, approach to stormwater mitigation. In 2003, the City voted to amend the Zoning Regulation Bylaw to allow, and even to encourage, the use of permeable surfaces, “in addition to asphalt and concrete.” The amendment encourages developers to “consider consolidated surface materials such as grasscrete, grass pave, SF-RIMA, and brick pavers,” though their code remains opposed to crushed rock, gravel, grass or other loose materials. Their stated intention in making the change was to preserve a “cleaner marine environment,” to reduce tax expenditures on stormwater drainage system improvements, to reduce the quantity of impermeable/solid surfaces, and for improved aesthetics.⁸²

Relevance to Seattle: Permeable paving, as discussed above, allows for greater infiltration of water into the ground, reducing the burden on the water treatment system and reducing the amount of pollutants flowing into Elliott Bay. Seattle should encourage the use of permeable paving in all parking lots, specifically downtown. This could be accomplished by inclusion of permeable paving into the updated sustainable street design policy, providing still another incentive for offsetting impermeable surfaces. Alternately, the City could consider requiring permeable paving in all ground-level parking lots, with failure to comply resulting in a stormwater runoff tax on the cost of parking lot development. The success of regulation would in part depend on the City’s willingness to allow developers flexibility of paving type and usage.

Portland, OR

Similar to Seattle, the Portland metro area has a detailed policy on “green streets.” Also similar to Seattle, Portland has been planning for its future in the form of a long-term growth plan, the 2040 Metro Growth Concept and Regional Transportation Plan. In these and many other ways, including geography, climate, and populace, the two cities are strikingly similar.

Portland, in laying out its regional growth plans, has attempted to define a new operating paradigm: to use as “guiding principle” the ethos of “conserve, protect and restore the environment as first consideration.” The City also seeks to institutionalize “integrated decision making,” noting that the environment and all other spheres of influence are not merely discrete units, but rather are interconnected entities in which problems within one system invariably tie into other systems. To this end, the City has attempted to define a holistic approach to green streets, recognizing that “ecological health (is) found in an integrated approach to urban development acknowledging needs for a healthy habitat for humans and other species, and the requirements of modern urban living.” To strive towards these goals, the City has laid out a comprehensive definition of green streets as streets that:

- integrate a stormwater management system within the street right-of-way,
- reduce the amount of stormwater runoff,
- are visible elements of the “green infrastructure” system,
- use trees for stormwater and temperature mitigation,

⁸² Retrieved on 18 Feb 2004 from the City of Victoria website:
http://www.city.victoria.bc.ca/cityhall/pressroom_rel_030205a.shtml.

- ensure street has least impact on surroundings, especially at locations where it crosses a stream or other sensitive area, and
- “require a more broad-based alliance for its planning, funding, maintenance and monitoring.”⁸³

Conversations with Portland officials make clear that the City is not content merely to define green streets, thenceforth continuing with business as usual. Indeed, as described in Metro’s (the Portland metropolitan regional planning agency) Green Streets: Innovative Solutions for Stormwater and Stream Crossings, City officials paint a picture of a city in which both the City and developers are “starting to make sustainability part of their marketing, part of their way of doing business.”⁸⁴ Senechal-Biggs goes on to note that developers who are “going green” are getting “more press, attention, and awards” than they could generate for themselves, which seems to be matching the “groundswell in the architecture and design community” that appears to desire to move towards more overall sustainable design.

Seeking to develop streets more sustainably, the City has recently received grant money to develop a number of pilot projects. In one such development, the City is looking to reengineer and undertake a “green street rebuild” on a street that is currently an asphalt-paved road with no sidewalks or bike lanes in an area that is primarily low-income – an area, Senechal-Biggs points out, that is more likely than many others to *need* alternatives to auto transportation. The hope for this street is that it will be redeveloped with numerous sustainable street design features. However, as described below, the City already has a number of initiatives underway that attempt to address the various functions of sustainable street design.

Bicycle and Pedestrian Orientation: Portland has developed an extensive set of guidelines and expectations for bicycle- and pedestrian-orientation of its streets. Since passage of a bicycle bill in the 1970s that mandated a certain percentage of all road spending be spent on bicycle facilities, Portland has moved increasingly towards considering all road design multimodally, that is, looking at roads as the sum of all their parts, with emphasis on providing for *all* users of the roadway. The City has codified this status numerous times, most strongly in the Pedestrian and Bike Master Plans. These plans serve as guidelines for all potential stakeholders – advocates, planners, and developers – laying out the expectations of the City. Accompanying the Plans, the City hosts annual training for all staff, as well as for the design and advocacy communities, to communicate the City’s intentions regarding bicycles and pedestrians.

Though Portland was one of the first cities in the nation to create positions for specialists in bicycle and pedestrian issues, in recent years those people have been reintegrated into all planning departments. In the words of Senechal-Biggs, they have learned that a “key to any project’s success is analyzing all aspects.” The integration of specialties throughout all relevant agencies enhances Portland’s ability to do that.

In terms of bicycle- and pedestrian-orientation of public rights-of-way, Portland is working hard to create and promote a comprehensive network accessible to the whole city. While funding is

⁸³ Green Streets: Innovative Solutions for Stormwater and Stream Crossings. Metro; Portland, OR. Jun 2002. P. 2.

⁸⁴ Phone interview with Jean-Senechal Biggs, Project Manager, Portland Department of Transportation (PDOT), on 11 May 2004.

short, the City has reevaluated their thinking to wisely use data so as to put bike and pedestrian lanes in areas that make the most sense, fiscally, such as piggybacking on road redevelopment that is already ongoing (as opposed to deciding to add a bike lane, for example, in a piece of road not otherwise being redeveloped).

According to Barbara Plummer,⁸⁵ Portland has also been working at further developing an idea borrowed from Palo Alto, California, that of bike boulevards. In these, the City takes a “relatively quiet neighborhood,” often streets with good connectivity that have historically been cut-through and are not pedestrian friendly, and diverting car traffic off of those roads while keeping them accessible to cyclists. The City is using traffic circles, diverters with bike cut-throughs, speed bumps, bike boxes (that is, the creation of special bicycle waiting areas at stoplights in the area between the crosswalk and the stopping line for automobiles), and signal timing to place cyclists on par with or prioritized over the auto. Portland has also been installing bicycle buttons for crosswalk lights (similar to pedestrian buttons but at street level on the curb, accessible to cyclists), and has painted stencils on the road to show bicyclists where pavement (traffic light) weight-sensor “hot spots” are. In addition, the City offers summer bicycle rides for new riders, showing different areas of town that are particularly bicycle friendly while encouraging community interaction and getting people out on bicycles.

Portland has also been working to develop walking programs to promote walking in general, and walking to work in particular. Recently, the City has partnered with local businesses to develop a program in which walkers are eligible for discounts on shoes and other products along their routes, as well as partnering with a health company to do before and after health screenings of walkers. As with the bicycle program, Portland also offers summer walking groups, touring through areas on summer evenings.

Stormwater mitigation: The city of Portland currently has a number of projects featuring sustainable street design techniques either underway or slated for construction. The City has developed a number of projects in the public right of way, and has used various techniques, including different forms of bioswales, different styles of curb construction, and pervious paving. Indeed, the City has given strong recognition to the importance of effectively managing stormwater runoff, in turn recognizing the “need for non-traditional solutions.”⁸⁶

Portland has been working on numerous projects incorporating sustainable stormwater mitigation techniques in the public right-of-way. These include pervious concrete, pervious concrete pavers, and landscaped curb extensions above storm drains (which allows stormwater to soak slowly into the landscaped area while wetland plants filter out some pollutants). More and more, Portland street design has been seeking to “mimic natural conditions while improving water quality and neighborhood aesthetics.”⁸⁷ Further, the City is striving to develop projects that demonstrate the ability to build new streets or redevelop/retrofit old streets to sustainably

⁸⁵ Phone interview with Barbara Plummer, PDOT Options Department, on 11 May 2004.

⁸⁶ “Sustainable Infrastructure Alternative Paving Materials Subcommittee Report.” City of Portland’s Sustainable Infrastructure Committee. 3 Oct 2003. P. 3.

⁸⁷ Retrieved on 2 May 2004 from Portland’s Environmental Services website: http://www.cleanrivers-pdx.org/clean_rivers/siskiyou.htm

manage stormwater effectively and inexpensively.⁸⁸ Portland is also seeking to redevelop a main arterial in a way that will include, through an integrative community process, a “pedestrian-friendly commercial district that reflects and reinforces community values, including a focus on sustainable and “green” development,” in particular, “green infrastructure opportunities...within the public right-of-way.”⁸⁹

As might be expected given Senechal-Biggs’ comments that sustainable development is being seen as a public relations bonus, the City also reports numerous examples of the use of sustainable stormwater mitigation techniques out of the public right-of-way. These examples include parking lots at a variety of commercial locations.

Greenscapes: Portland is currently working on a number of redevelopment projects, and is actively seeking to incorporate elements of greenery and street trees in all of them. In 1992, Portland enshrined the desirability of greenspace development into a regional plan, called Portland Greenspaces. This plan “describes a unique regional system of parks, natural areas, greenways and trails,” identifying a number of urban areas defining the green infrastructure of the Portland region. The Plan, which was supplemented in 1995 with a \$135 million bond measure, provides for the acquisition of open space, as well as creating land-use standards, incentives and stewardship.⁹⁰

Portland places significant value on street trees, recognizing them as “fundamental to (the) city’s livability” for their abilities pollution offsetting assets, for their shade and its benefits, for providing habitat for wildlife, and for their aesthetic value. Further to that, Portland has a Tree Cutting Ordinance regulating the removal of any trees at or over one foot in diameter on specified private properties, as well as in the public right-of-way.⁹¹

Obstacles: As in other sustainable street design efforts, Senechal-Biggs and Plummer both commented on the need for additional funding to try some of the more innovative elements of sustainable street design. Unsurprisingly, numerous municipalities noted this as a challenging aspect of sustainable street design. Senechal-Biggs also noted that one of the key challenges for sustainable street design in Portland, based on resources available, is maintenance of projects they have already developed; currently, the City is mostly undertaking maintenance only in response to complaints.

Relevance to Seattle: As in a number of cities in this study, Portland officials stressed the importance of having buy-in from all levels of stakeholder, from neighborhood citizens to City departments, in undertaking sustainable street design. The City has made an admirable attempt to establish sustainability as an overarching feature in street design, as well as in how the city functions in general. Seattle, too, has made considerable efforts to this regard. However, Seattle could, it would seem, do more to emphasize sustainability across all City functions, particularly

⁸⁸ Ibid.

⁸⁹ Retrieved on 5 May 2004 from Portland’s Bureau of Planning website: http://www.planning.ci.portland.or.us/cp_div_over.html

⁹⁰ Retrieved on 20 May 2004 from Metro’s Parks, trails and greenspaces website: <http://www.metro-region.org/pssp.cfm?ProgServID=5>.

⁹¹ Retrieved on 20 May 2004 from the Portland Parks & Recreation Urban Forestry website: <http://www.portlandparks.org/urbanforestry/UrbanForestry.htm>

within sections that often do not seem particularly green or to which green ideas do not necessarily seem like natural extensions of normal operational expectations.

Seattle could also incorporate a number of Portland's bicycle and pedestrian initiatives, including the creation of bike boulevards, the clear labeling of bicycle lanes, incorporation of road crossing buttons for cyclists and timing of traffic signals for bicyclists. Further, in efforts to educate the public as well as create buy-in and a constituency for implementation of a more robust sustainable street design policy, Seattle could work to offer community rides and walks to familiarize people with neighborhood walks and rides, and to encourage non-motorized commuting. Though numerous community groups currently encourage many of these things in Seattle, a more active role by the City might prove a catalyst for more significant change, as envisioned in Mayor Nickels' proclamation of Seattle's future as the "most bike- and pedestrian-friendly city in America."

Seattle should also make every effort to attain funding from non-City sources, including grants, to enable it to further experiment with sustainable street design techniques, exploring new ideas and technologies.

Finally, as with Vancouver, from a broader perspective development of a solid, regular relationship between Portland and Seattle has a great deal to offer. Again, these are cities that share a good deal in terms of size, resources, climate, and topography. Portland, like Vancouver, has been part of recent efforts to strengthen regional coordination of sustainable street design BMPs and policies, and continued collaboration will greatly strengthen the work of both Cities. Again, the two show considerable opportunities for learning from each other's efforts. As discussed in the Vancouver section, the network of communications that is being developed will be instrumental as the three cities work to incorporate increasingly bold and varied BMPs for sustainable street design, and great attention should be paid to ensuring its viability.

CALIFORNIA

Davis, CA

Davis arguably began the first truly sustainable street design in the 1970s with the creation of Village Homes. This development incorporated sustainable stormwater management, connected bicycle- and pedestrian-oriented streets and house development, replete with greenspaces and street trees. In addition, the City developed, in the 1980s, a number of stormwater detention basins. In the mind of John McNerny, Wildlife Resource Specialist for the City's Public Works, these basins, originally required of developers to "mitigate for stormwater quality impacts from initial development (sediment) and future runoff issues (pesticides, fertilizers, automotive byproducts), were largely the results of "a 'right thing to do' type mandate."⁹²

While the right thing to do mandate definitely holds sway today, McNerny also commented that developers are increasingly seeing stormwater basins as "a valuable addition to their development," with their presence (and that of the wildlife in them) resulting in higher home values for houses adjacent to the "naturalistic features."

⁹² Email interview with John McNerny, Wildlife Resource Specialist with Davis Public Works, on 3 May 2004.

The City is working to develop a parking lot utilizing permeable concrete, which is slated for completion this summer. They have also tried using asphalt rubber on their streets in efforts to improve permeability, and a number of City departments are collaborating to see the inclusion of permeable paving, vegetative swales, and detention ponds into the design of a large new development currently being proposed (the first such development in quite some time).

Relevance to Seattle: It is instructive to note that property values have risen near “naturalistic,” yet utilitarian, stormwater mitigation elements. In education campaigns, Seattle should heavily promote the aesthetic aspects of stormwater mitigation and pedestrianization techniques and their subsequent value to landowners and developers as incentives for private development of such greenery. It would cost the City nothing, but could increase interest in sustainable street design.

Santa Monica, CA

Internet research and interviews with both a Civil Engineering Associate and the Coordinator of Urban Runoff show that Santa Monica, California, has begun adoption of some of the more innovative stormwater mitigation techniques in the United States. These innovations include the development of recycled rubber sidewalk pavers (which help with street tree root and permeability), installation of pervious concrete pavement gutters to manage dry-weather runoff and first-flush pollution, and the construction of an urban runoff recycling facility for dry-weather flows. The rationale behind these innovations has been, in part, a proactive sense of environmental stewardship by city decision makers, an ethos evidenced in the Santa Monica’s Sustainable City Plan (passed in 1995 and updated in 2000).

However, Santa Monica’s aggressive approach to stormwater mitigation has also been partly in recognition that health, both human and economic, were being directly affected by stormwater runoff. According to City officials, the Santa Monica Urban Runoff Recycling Facility (SMURRF) is the first of its kind in the world, built in response to a number of epidemiological studies that showed people were getting sick from urban stormwater. Santa Monica depends heavily on tourism related to their beach and bay, so it quickly became evident that it would be in the city’s best interests to have its water be as clean as possible. The plant went online in February of 2001, and the City now sells recycled water from the SMURRF.

In addition, the City Council created a requirement that buildings of a certain size must retain within their property 20% of all runoff from that property. According to Civil Engineering Associate Antonio Shaibani, this is usually accomplished by “increasing pervious surfaces, by incorporating permeable pavers or gravel, and in some instances, by installation of infiltration ponds to collect runoff.”⁹³

Stormwater management is not the only field in which Santa Monica is working to implement sustainable street design techniques. The City has also been working to improve its pedestrian accessibility, particularly in the downtown core. To that end, they have been narrowing streets and widening sidewalks, putting in bulbouts, pavers, and in-pavement flashers to slow traffic.

⁹³ Telephone interview with Antonio Shaibani, Civil Engineering Associate, on 10 May 2004.

Relevance to Seattle: While Seattle has long shied from regulation, the creation of a regulation stating that new developments must retain a certain percentage of their rainwater runoff on-site would be another way to enhance sustainable street design. Alternately, to take into account particularly expensive or challenging (to engineer) situations, the City could charge a fee for developers *not* accounting for 20% of their runoff (or another, perhaps graduating, percentage). If applied fairly across all developments, this would simply become another factor of development in Seattle, disadvantaging no one more than anyone else. As noted above, regulations could be accomplished in tandem with various incentives to create a complete policy.

Like Santa Monica, Seattle relies significantly on the health of Puget Sound and Elliott Bay for food as well as tourism. The City should act proactively, following Santa Monica's lead, in efforts to sustainably manage urban runoff in a way that protects its natural resources. As an addition to the educational campaign elements already discussed above, bringing attention to the important tourist resource that is the Sound should be a key City priority.

THE WEST

Boulder, CO

Boulder has created a system of "Transportation Management Organizations" (TMO) collectives that pair businesses with developers and residents to improve mobility in Boulder. These TMOs are based on a collaborative effort with leadership shared among the different stakeholders, giving all interested parties a solid voice in the process. They are intended to help develop Transportation Demand Management (TDM) services, particularly as related to the workplace.⁹⁴

Relevance to Seattle: Seattle should consider creating similar versions of public/private/citizen partnerships to develop and improve BMPs, as well as seeing to their implementation. Similar to Minneapolis's use of public design charrettes, organized committees of residents, business leaders, and public officials might serve to create more organizational buy-in on stormwater management and bicycle- and pedestrian-oriented street design, as well as serving as a forum for developing new ideas. These committees could lead to development of local improvement districts in which residents would develop projects such as country lane-style alleys.

THE MIDWEST

Maplewood, MN

Maplewood, Minnesota, population 30,954, lies about ten minutes from downtown Saint Paul, MN. According to the City's website, surface water management is seen as critical to protecting and enhancing "the environmental features of the city," as demanded by their City Council.⁹⁵ In 1996, Maplewood undertook a pilot (in conjunction with the University of Minnesota and two

⁹⁴ Retrieved on 12 Apr 2004 from

http://www.ci.boulder.co.us/publicworks/depts/transportation/master_plan_new/pdfs/TMO_overview.pdf.

⁹⁵ Retrieved on 26 Apr 2004 from Maplewood's website:

http://www.ci.maplewood.mn.us/index.asp?Type=B_BASIC&SEC={857C9E90-CFC6-49EE-9BB3-DB8685F2F0C5}.

other partner agencies) to create a swale along a public right-of-way. The project, developing what Maplewood calls a rainwater garden, has proven quite successful. To date, over 130 rainwater gardens have been established, on a combination of both public and private properties. Over 100 more are currently under development or slated for development. The largest is over 5000 square feet, and neighborhood volunteers and youth groups tend the public gardens.

The rainwater gardens, of which one is pictured at right, essentially function as swales. They are described as areas of plantings located near buildings or paved areas that naturally filter stormwater (or snowmelt) routed to them. They act as “micro-detention pond(s),” naturally, easily and cheaply reducing the flow of polluted water into the stormwater system. The City reports that these gardens can work nearly anywhere, with location, size and effectiveness being dependent upon the number and size of downspouts, buildings, and receiving areas for rainwater. The City notes a number of beneficial aspects to the rainwater gardens, and encourages citizens to install their own on residential property. The benefits reported by Maplewood are detailed in the chart below.



Maplewood, Minnesota - Benefits of Rainwater Gardens	
<ul style="list-style-type: none"> • Minimal maintenance (occasional weeding/plant replacement) once established • Efficient natural filter to reduce polluted runoff • Can serve as flash flood deterrent 	<ul style="list-style-type: none"> • Attracts wildlife, birds and butterflies • Aesthetically pleasing • Recharges / renews groundwater • Slows water flow from impermeable surfaces

To develop rainwater gardens in the public right-of-way, Maplewood created and, in the winter of 2003, implemented an “Environmental Utility Fund” (EUF), a fee the City likens to the service charges long used by communities for financing sewer and water systems. This fund, which the City is quick to point out is not “a new tax,”⁹⁶ is funded through a monthly \$1.75 fee (charged to each household) that is, according to the City, similar to a water or sewer bill. Industrial and commercial entities are charged a site-specific amount “equivalent to the amount of parking surface and impervious roof area” for the EUF.⁹⁷

According to Maplewood engineer Erin Laberee, both commercial properties and residential properties may apply for a reduction of up to 75% of their fee for the construction of BMPs on their site.⁹⁸ As noted, the fee is available to residents and commercial entities – creating an incentive for home- and business-owners to develop stormwater mitigation BMPs, such as rainwater gardens. Given the short time the program has been in place, it is hard to say what

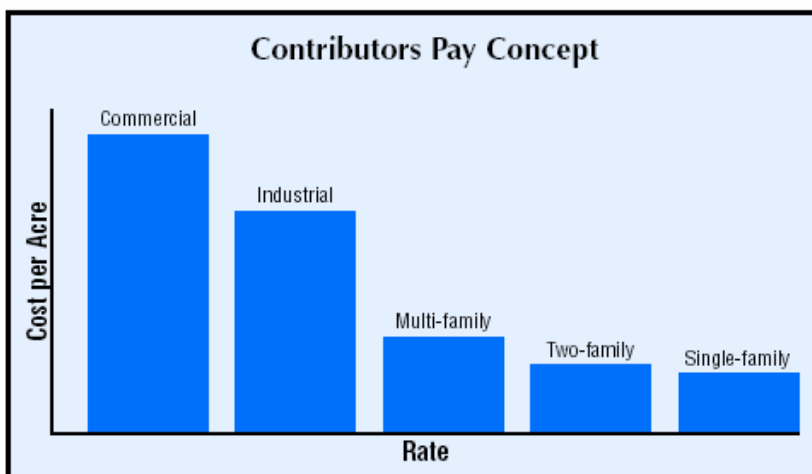
⁹⁶ “Financing Maplewood’s Storm Water Management with a Environmental Utility.” Maplewood, MN. Retrieved on 27 Apr 2004 from <http://www.ci.maplewood.mn.us/vertical/Sites/{EBA07AA7-C8D5-43B1-A708-6F4C7A8CC374}/uploads/{0B843A98-93F5-496B-A605-FC40D93C5E47}.PDF>.

⁹⁷ Billing according to contribution, as described here, is termed the “Contributors Pay” concept. Ibid.

⁹⁸ Email interview, 11 May 2004 and 12 May 2004.

long-term demand for the credit will be. However, to date the City has had three commercial, two institutional, and 12 residential properties request the credit.

Maplewood has produced a brochure, entitled “Financing Maplewood’s Storm Water Management with a Environmental Utility,” stating that the money collected in the EUF is levied “based upon how much water runoff and/or pollutant load is contributed by a particular parcel,” and is utilized for surface water management. The fee does not, the City notes, replace any existing funding, but rather, it complements them. However, since the fee is ongoing, it provides a dedicated source of funding for stormwater management and all related activities. The Contributors Pay Concept chart below graphically displays this.



Interestingly, development of rain gardens is somewhat more expensive than development of traditional landscaping, partly due to the need for additional soil excavation, backfill material, use of underdrains, and a greater number of plantings.⁹⁹ Indeed, a general estimate for development of rainwater gardens is an average of approximately three to four dollars per square foot (depending on local soil, plant species and quantities).

However, their creation can save considerable money in the long term, reducing the public burden of stormwater management. This creates a natural incentive for their construction by municipalities, particularly for utilities responsible for stormwater management; they also have an incentive to encourage development by citizens (to reduce demands on the public system).

Relevance to Seattle: The EUF seems an ideal funding idea for Seattle to develop the financial resources for public development of sustainable streets. Seattle residents have shown a willingness to pay an additional amount of money on energy bills for so-called “green power,”¹⁰⁰ which can be assumed to imply a willingness to pay for a community environmental good, and the connection between tax and service provided should be clear with the fee on utility bills.

Further, as Maplewood’s brochure points out, this fund is self-financing, serves as a source of dedicated funds, does not increase property or other taxes, and can be easily sold to the public on the basis of fairness: charges are based on the amount of runoff from a piece of property, as opposed to any sort of economic valuation of that property. Finally, the resultant long-term cost

⁹⁹ Retrieved on 17 May 2004 from the Low Impact Development Center, Inc. website on Bioretention Cell Costs: http://www.lid-stormwater.net/bioretention/bio_costs.htm

¹⁰⁰ Seattle City Light offers additional fees for supporting development of alternative (to fossil fuels) energy sources. These fees range from \$3 (residential) to \$150 (for large-scale commercial), and are gaining in popularity. In August 2003, this voluntary program had over 59,000 customers, representing nearly 17% of the utility’s customers. Retrieved on 26 Apr 2004 from <http://www.ci.seattle.wa.us/light/Green/greenPower/faq.asp> and http://seattlepi.nwsourc.com/local/135982_greenpower21.html.

savings from the reduced need for water treatment facilities could, at some point, be refunded as a reduction in residents' bills, or could be used for alternative needs.

Minneapolis/Twin Cities, MN

A city of nearly 400,000 (with nearly three million in the Twin Cities metropolitan area),¹⁰¹ Minneapolis is working to understand and implement various sustainability initiatives. Central to those efforts is work the City is undertaking on a Sustainability Plan, slated for completion in 2004, which will create a series of indicators and performance measures for more sustainable operations citywide.

Regarding sustainable street design, Minneapolis excels in the area of bicycle- and pedestrian-orientation. It has been working to better understand and plan for the needs of bicyclists, in particular in hopes of encouraging a significant increase in the number of residents commuting by bicycle. Currently, approximately four percent of Minnesota residents commute by bicycle. Minneapolis developed a study to determine current bicycle usage and ways of building upon that usage. One of the key findings of that study was the strong assertion by the vast majority of Minnesotans surveyed that bike lanes, separate bike paths, and secure bike storage at work would be "very important or somewhat important" in getting them to bike to work more often.¹⁰²

Conversations with Minneapolis officials confirmed the results of the survey, as well as the City's intent to act upon those results. According to Don Pflaum, Transportation Engineer in the City's Traffic and Parking Services Department, Minneapolis has been making considerable efforts to include bicycle and pedestrian needs in all road development and redevelopment. Quick to point out that the city is relatively small, constrained by surrounding municipalities, he also notes that all development in the city now takes into account bicycle and pedestrian needs.

Interestingly, Minneapolis has been creating an extensive public-involvement process in the redevelopment of its streets, and in the development of a comprehensive network of bicycle paths. Specifically, he noted that, "the City has decided to take a more holistic approach to selecting routes for future consideration, whether a signed bike lane or a bike trail, etc."¹⁰³ The City has an ambitious goal of building a citywide bicycle grid accessible to nearly everyone, with trail lanes spaced a mile apart and bike trails one-half mile apart such that everyone in the city living within a half mile of a bike trail and within a quarter mile of an on-street lane.

In pursuing this strengthened bicycle and pedestrian focus, according to Pflaum, the City asked 67 neighborhood groups (of 81 distinct neighborhoods in Minneapolis) to each develop a proposal of what they would like in terms of bicycle and pedestrian amenities. The City gave them a few months to provide input and comments, and then plotted the various proposed routes on a map of the city. Not surprisingly, Pflaum stated, "there was a lot of disjointedness." In response, the City held four different design charrettes, including one delegate from each neighborhood to resolve the differences. For example, if one neighborhood wanted to see a

¹⁰¹ Retrieved from the AreaConnect webpage on 27 Apr 2004: <http://minneapolis.areaconnect.com/statistics.htm>

¹⁰² Jackson, Mary Elizabeth, and Newsome, Pamela. "A Guide to Bicycle Transportation in the Twin Cities Metropolitan Area: The Processes, The Players, The Potential." St. Paul, Minnesota. Sep 2000. P. 9.

¹⁰³ Telephone interview with Donald Pflaum, 19 May 2004.

particular road redeveloped as a bike route, and a neighboring group wanted a different road, the City used the charrettes to work out details, with the City providing technical advice to ensure realistic planning. The City is now in the process of completing the five-year plan, and is looking forward. A series of implementation committees have been created, again using neighborhood delegates, to move forward with things.

Nor is the addition of bicycle lanes the only move towards sustainable street design in Minneapolis. The City is also considering a number of other innovations, including the replacement of parking lanes with bicycle lanes, the use of building codes and development ordinances to ensure the addition of bicycle lockers, bike parking, and showers in all buildings and developments over a certain size, narrowing of streets (and subsequent addition of green spaces and median planters), as well as various traffic calming elements.

Some of the most pressing concerns in the redevelopment of Minneapolis roads in a more sustainable style include considerations regarding operations and maintenance, as well as making smart planning decisions. For example, Pflaum noted that some areas have seen commercial development in the past whose design and footprint now work to effectively limit possible redevelopment of the abutting streets. Effective planning regarding appropriate land use will, in his opinion, reduce these problems in the future.

Relevance to Seattle: As discussed above, the importance of codification of preferred design techniques is crucial for successful development of desired behaviors. Seattle should move to change building codes and development ordinances to require bicycle lockers, bike parking, and showers in all buildings and developments over a certain size. While Seattle has a generally inclusive process for development and design, it is instructive to note Minneapolis's increased use of neighborhood design charrettes to determine best possible routes for new paths.

Madison, WI

The city of Madison, Wisconsin, has been working to further develop and utilize all three of the sustainable street design elements discussed in this paper. Though smaller, Madison is similar to Seattle in that it, too, has a highly educated populace and a political climate that encourages innovation.

Bicycle and Pedestrian Orientation: Madison is a very bicycle- and pedestrian-friendly city, and continues to seek to improve its infrastructure for bicycles and pedestrians. According to Christy Bachmann, an engineer in the City's Street and Highway Section, all Madison streets are now designed to accommodate bicycle travel, either by having a widened lane (for example, on local streets, ensuring sufficient width for safe bicycle travel) or through the addition of five-foot bicycle lanes, generally on collectors and arterials. As a result, as Madison engineer Greg Fries notes, "It's almost unheard of now not to put in bike lanes."¹⁰⁴ Further, Bachmann noted that the City puts sidewalks on both sides of the street everywhere, excluding short cul-de-sacs.¹⁰⁵ The

¹⁰⁴ Phone interview with Greg Fries, Madison city engineer, on 25 Mar 2004.

¹⁰⁵ Phone interview with Christy Bachman, Street & Highway Section, Madison Department of Public Works and Transportation - Engineering Division, on 10 May 2004.

City designs all Madison street development, though developers build it. Accordingly, the inclusion of bicycle lanes and sidewalks are a condition for approval of any development.

According to Bachmann, the City has been actively engaged in promoting bicycling through building bike lanes since the 1980s. A college town, many Madison residents depend on bicycles as their sole means of transportation. Further, the Wisconsin Department of Transportation (WISDOT) requires bicycle accessibility on state roads, creating an additional incentive for the City to create bike lanes.

The process of including bicycle lanes into the streets has been part of an ongoing effort in interdepartmental and interagency collaboration. Also, besides adding the lanes, Madison has been working to narrow the street width standards, link neighborhoods (in some instances through the removal of cul-de-sacs) and add traffic calming devices (including traffic circles and speed tables), changes that affect a number of departments and agencies. To ensure departmental buy-in and effective policy decisions, Madison departments work together to create, review and amend regulations. This ensures not only that the regulations work for utilities, transportation, and emergency services, but also that all departments are in agreement on the details of various policies and policy changes, and that all accept them.

Madison also has a community-based program called the Red Bike Project. This program provides a series of bright red, unlocked bikes parked around the downtown Madison area that can be used, free-of-charge, by anyone at any time. A Yellow Bikes program is also available, in which people can pay \$75 to rent a bike, helmet and lock for an indefinite time period.¹⁰⁶

Stormwater Mitigation: Madison is relatively new to the stormwater mitigation aspects of sustainable street design, but recent stormwater management plans have created strong incentives to develop new methods and processes.¹⁰⁷ Historically concerned more with snow management, new standards created by both Wisconsin and Dane County (in which Madison sits) set suspended solid requirements (requiring fine micron particle control), require infiltration in all new developments, establish oil and grease controls, and require thermal controls to ensure water that is too warm does not enter coldwater streams, or the opposite.

The City is currently working on developing a small pilot based on Seattle's SEA Street. Labeled a rain garden street, Madison's first sustainably designed street project intended for stormwater mitigation is being developed in a residential neighborhood. According to Fries, the development is largely a result of pressure from a community environmental group, and is being carried out with the help of a grant from the Wisconsin Department of Natural Resources. The design process has included two neighborhood meetings to date, as well as a walking tour/meeting (of the proposed changes) and mailed ballot to gain public involvement and buy-in.

Fries noted that relatively few people seemed concerned about the development, a positive sign that is particularly important as City policy requires a ballot be mailed to neighborhoods to be

¹⁰⁶ Retrieved on 1 June 2004 from the Red Bikes Project homepage: <http://danenet.wiclip.org/bcp/redbikes/>.

¹⁰⁷ According to the University of Utah's Department of Meteorology, from 1961-1990 Madison received an average of 30.88 inches of rain annually as compared to Seattle, which received 38.00. Retrieved on 26 Apr 2004 from <http://www.met.utah.edu/jhorel/html/wx/climate/normrain.html>.

affected by potential changes, and ballots must be returned with at least a 50% response rate for a project to proceed.¹⁰⁸ The City's engineering staff will design this particular project, like all other street reconstruction and new construction projects in Madison, and the City will hire consultants to select and undertake the plantings. It will mainly entail the construction of bioswales, the plantings in which will be maintained by neighbors. Should this project be a success, Fries noted, and should more such projects be undertaken, the newly hired water resources engineer would likely be tasked with planting selection and completion.

Greenscapes: Madison has had an active street trees program since the 1950s, and City of Madison forestry crews maintain street trees. The City also requires developers to turn open spaces into parks (as opposed to simply leaving them as open spaces), which has resulted in an increase in private parks situated in and near developments.

Relevance to Seattle: Similar to the relevance of Minneapolis, Seattle should consider creating a policy requiring bicycle lanes on all major arterials and collectors, and should encourage and undertake the creation of a city-wide network of bike paths. While right-of-way issues will definitely arise, Madison's example of requiring them in all developments and on all roads sets an example that once such a standard is created, it becomes simply the way business is done.

Michigan

Michigan, home of the automobile, has begun to realize that the status quo of street design is too exclusionary, focused as it is solely on auto travel. Indeed, according to an article by the Michigan Land Use Institute, Michigan's "highway-dominated transportation policy" has led to runaway sprawl, in turn generating rough roads filled with interminable traffic jams, and poor public transit options, factors which contribute to wasted government dollars, weakened communities, and economic disadvantage for job seekers (Schneider). Accordingly, the Michigan House of Representatives has, at the encouragement of the bipartisan Michigan Land Use Leadership Council, adopted legislation mandating context sensitive design. The central tenets of context sensitive design (CSD) are the recognition and preservation of "historic, scenic, natural environment, and other community values on an equal basis with mobility, safety, and economics," according to Mary E. Peters, director of the Federal Highway Administration (Thayer).

Context sensitive design has also come to be seen as a way to ensure community involvement in the transportation planning process. CSD, defined in a Michigan Governor's Executive Directive as "collaborative, interdisciplinary approach involving stakeholders...that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility." Established by Governor Jennifer M. Granholm in 2003, this Directive calls for the creation of communication strategies that both inform and address concerns of interested groups throughout the design and construction process. The Directive further orders that the Michigan Department of Transportation (MDOT) use context sensitive design "whenever feasible" in transportation projects, and that it educate its staff and consultants about CSD, seeking to develop policies to spread and further develop CSD. In keeping with the

¹⁰⁸ Fries noted that most projects see an 80-90% response rate, because "most folks care what happens on the street in front of their house."

central notions of CSD, the Directive also mandates that MDOT collaborate with and consult citizen and interest groups to ensure all concerns are addressed.¹⁰⁹

Not surprisingly, some in the MDOT see context sensitive design as heretical new policy. Indeed, an article published in February of this year makes note of the fact that “until very recently,” the connection between road construction and community stability was seen as “almost taboo” at MDOT, for reasons of economics (the cost burden of increased criteria for roadbuilding) as much as institutional culture (Thayer). Some of this change may be attributable to the Governor’s convictions, which she made clear at a transportation summit last summer: “...crafting a 21st-century transportation system entails...building and connecting communities...creating livelihoods, economic stability, and reaching out beyond our borders and comfort zones” (Thayer).

However, Governor Granholm is not alone in pushing for new, more up-to-date policies on transportation. The newly appointed director of MDOT, Gloria Jeff, is a nationally recognized advocate of CSD. With the combination of the Governor’s Executive Directive and Jeff’s leadership, Michigan is poised to enter a dramatic new era of transportation planning. This new direction will incorporate bicycles, transit, and walking as complements to a community, “enhancing downtowns, neighborhoods, and the natural environment” and resulting in slower vehicle speeds and more road space dedicated to non-automobile uses, which in turn makes for safer roads. Further, numerous citizen groups are encouraging context sensitive design, and are doing so in part for civic pride, arguing that Michigan should reclaim their communities and once again take their place as a national transportation leader, as when Michigan laid the first mile of concrete and painted the nation’s first center line (Thayer). Interestingly, context sensitive design has also been gaining steam in other parts of the country, including within the highway department of the state of Maryland as well as WSDOT.

Relevance to Seattle: One problem with the current Director’s Rule uncovered in conversations with numerous developers is a lack of project-specific flexibility. The City could gain considerable opportunities to both encourage (through incentives) and regulate sustainable street design-type behaviors should it amend its code to allow for more flexibility within a given set of design expectations. It would be of great importance to define the design expectations to which all projects would be held, such as providing bicycle lanes or retaining a certain percentage of permeable surface (or the requirement of a payment, such as the EUF discussed above, to mitigate the impacts of impervious surfaces). However, once those standards are defined, the City could see substantial variance upon design standards as context-appropriate to a location.

Chicago

Chicago’s Mayor Richard M. Daley is an avid bicyclist who has pledged to “make Chicago the greenest metro area in the United States.”¹¹⁰ He appears well on his way towards those goals,

¹⁰⁹ Executive Directive No. 2003-25: Context Sensitive Design for Transportation Projects. Retrieve on 17 Mar 2004 from the Office of the Governor’s website: http://www.michigan.gov/gov/0,1607,7-168-21975_22515_22533-83562--,00.html.

with the installation of a 20,000 square foot “green” roof garden on Chicago’s City Hall, rapidly expanding bicycle network, and renewed focus on greenscapes and sustainable stormwater mitigation practices. Indeed, conversations with Chicago officials, including the Assistant to the Mayor, show a city working hard at being one of the “greenest” cities in the nation – a cachet it seeks “to improve the quality of life for the people who live there.”¹¹¹ The City is making a considerable effort to “green” all City-built projects, including the use of LEED¹¹² building standards and the incorporation of sustainability goals into procurement, general services (the City’s “landlord”), and the Chicago Department of Transportation (CDOT). Essentially, the City is appraising how all its departments do business, and is seeking to green the entire process.

Bicycling and Pedestrian Orientation: As noted above, Chicago has taken bold steps in developing a citywide network of bicycle trails. In 1991, the Mayor established a Bicycle Advisory Council to encourage bicycling in Chicago, making the city more bicycle friendly and helping promote cycling as “a convenient and attractive transportation alternative.”¹¹³ Noting the value of those trails to people and wildlife (for which they serve as “habitat corridors” through which wildlife can pass), the City has been actively working to build and promote bicycle lanes since 1992, as a form of recreation as an alternative means of commuting – an effort that has seen a good deal of success, with the city now home to over 100 miles of bicycle paths and over 8,000 bike racks.¹¹⁴

Chicago has also developed a comprehensive website promoting bicycling, pointing out that bicycling is “healthy, fast, cheap, environmental, and fun.” Indeed, the City touts bicycling as a quick alternative to the automobile, with trips under three miles faster by bicycle.¹¹⁵ The website also promotes cycling as a means for staying in shape and relieving stress, as well as for the fact that bicycles do not require gas, parking, or insurance. The City has prioritized the creation of bicycle trails that “increase access to natural areas,” emphasizing not only the benefits of bicycling but also the greater connection cycling can provide with nature.¹¹⁶

Stormwater Mitigation: The City of Chicago is also actively working to find alternative methods of controlling stormwater runoff. In efforts to begin the process, the City has published “A Guide to Stormwater Best Management Practices.” This guide begins with the

¹¹⁰ Quote from Chicago Environment Department spokesman Mark Farina. Retrieved on 20 May 2004 from “Praise grows for lush roof in Chicago,” by Lee Rood, an article in the Des Moines register and available on the paper’s website: <http://www.dmregister.com/news/stories/c4788998/18823055.html>.

¹¹¹ Phone interview with Joe Deal, Assistant to the Mayor, on 6 May 2004.

¹¹² LEED, or Leadership in Energy and Environmental Design, is a voluntary national standard for “developing high-performance, sustainable buildings.” It was developed and remains administered by the U.S. Green Building Council, and serves as a way for cities, developers, and homebuilders to pursue common standards of integrated, environmentally and economically efficient building design. Retrieved on 20 May 2004 from the U.S. Green Building Council website: http://www.usgbc.org/leed/leed_main.asp.

¹¹³ Daley, Richard M. “A Message From the Mayor.” Retrieved on 12 Apr 2004 from the Chicago Department of Transportation webpage: <http://www.ci.chi.il.us/Transportation/Bikes/message2.htm>.

¹¹⁴ Retrieved on 12 Apr 2004 from the Nature Chicago website: <http://www.cityofchicago.org/Environment/NaturalResources/NatureChicago.html#Infrastructure>

¹¹⁵ Retrieved on 12 Apr 2004 from the City of Chicago Department of Transportation’s website: <http://www.ci.chi.il.us/Transportation/Bikes/commute.htm#why>.

¹¹⁶ Retrieved on 12 Apr 2004 from the Nature Chicago website: <http://www.cityofchicago.org/Environment/NaturalResources/NatureChicago.html#Infrastructure>

acknowledgement that ineffective management of stormwater damages private property (through flooding), overflows into the Chicago River and Lake Michigan (resulting in beach closures), and raises the cost of wastewater treatment through rising amounts of water running off into sewers and subsequent treatment plants. This publication challenges the notion that more environmentally acceptable solutions necessarily cost more or that permitting takes longer, and offers as a solution the provision of better information and public education, as well as improved design guidance (3). Further, the Guide is intended to provide clear examples to homeowners and developers alike of the many green options for stormwater management, as well as detailed descriptions of their installation and use.

Similar to cycling, the Mayor has put a near-personal emphasis on sustainable stormwater management. Indeed, Deal stated that his main focus since coming to the Mayor's office has been developing a conservation, water protection, and stormwater management plan. One of the primary foci of the City in recent times has been the goal of switching from “a hard infrastructure to a green infrastructure approach.” Rather than continuing with the thirty year-old custom of designing ever-bigger stormwater tunnels and associated systems, the City is now trying to “encourage and promote the BMPs” of sustainable stormwater management, including everything from “permeable surfaces to cisterns to raingardens to basic site design maximizing open space to green roofs.” Indeed, the City is shifting its focus from viewing stormwater as something for disposal and treatment, to seeing it as a resource, to be wisely managed and used.

One department in which the green focus can clearly be seen is the CDOT, which has been reevaluating how it approaches street design and functionality. For example, similar to Vancouver's efforts, CDOT has been working to disconnect alleyways from the sewer system. Rather than the “country lane” type design, however, CDOT has been working with French drains. Reporting a desire to return water to the ground and relieve the burden on the combined sewer system, Chicago now has around 30 French drains. An additional benefit with French drains, according to Deal, is that “at the surface, they look like a normal alley” – a feature that helps reduce negative reactions inspired by new, “strange” design elements.

CDOT has also been working with first flush runoff reduction. Specifically, on two of downtown Chicago's main arterials, City engineers have been developing a system whereby the first flush of rainwater to land on the roadway, which Deal estimated contains “98% of the pollutants once going into the waterway,” enters the sewer system, leaving the waterways to catch the much cleaner water that follows.

Traffic calming has also been a focus of CDOT, for both aesthetic and stormwater management reasons. The City has installed a series of median planters in the middle of a number of streets, as pictured below, and appears set to continue installing those where possible.

To ensure that the new focus is not merely seen in public works, Deal said, the City is working with developers to educate them about the new concepts. CDOT has been working with a developer seeking to develop at the confluence of Lake Michigan and the Chicago River, helping them develop a series of sustainable stormwater mitigation techniques. Specifically, they helped design and incorporate green roofs, the use of



permeable paving surfaces, and end-of-pipe pollutant systems to mitigate pollutants. In this particular case, Deal noted, the addition of so many environmentally proactive elements simplified the permitting process, proving a positive for both the developer and the City.

Chicago has been working to develop both incentives and regulations to promote such developments. Currently, developers can attain density (Floor Area Ratio, or FAR) bonuses on projects in the Central Area of the city by inclusion of public spaces, pocket parks, gardens, through-block connections, sidewalk widening, water features, riverwalks, green roofs, landscaping, pedway improvements, lower-level planting terraces, and a number of other design elements. The City is also contemplating regulatory changes to better structure development.

Greenscapes: As with bicycling, Mayor Daley is broadly promoting tree planting, stating that they should be planted “everywhere in the city where they can be accommodated.”¹¹⁷ “Trees soften the edges of life in a large urban setting,” Daley explained. “They add beauty to the environment, help cleanse the air, increase property values and provide shade that can lower energy costs on hot days.”¹¹⁸ In keeping with that, Chicago’s Bureau of Forestry plants 5,000 new trees annually, a task that can also benefit citizens personally: any Chicago resident can request a street tree be planted, free of charge, in front of their property.

Relevance to Seattle: As discussed above, Seattle should strive to incorporate sustainable design techniques into all aspects of government and into all public works, as well as promoting them in the private sector. Seattle has already made great strides towards this objective, but continued pressure to carry such initiatives at all levels of City government is crucial.

Further, as evinced by Chicago, private sector adoption of BMPs could be encouraged through development of quicker and more reliable permitting for projects utilizing BMPs. In addition, Seattle should consider creating a broad list of green features, such as the permeable paving discussed in Victoria or the various styles of drainage mitigation discussed in Chicago or Vancouver, eligible for FAR or similar incentives. This list should remain open to additions, in recognition of the rapidly changing knowledge of BMPs.

SOUTH

Austin, TX

Austin has developed a series of incentives that it uses to encourage specific types of smart growth development. The main incentive is a waiver of some or all of the development fees that a developer would normally pay the City. The amount is dependent upon a point system that has been established and that rewards preferable development. Specifically, developers earn more points for mixed-use developments or development around future rail transit stations or in the downtown area.

¹¹⁷ Retrieved on 17 May 2004 from the Chicago Department of Streets and Sanitation website: <http://www.cityofchicago.org/StreetsAndSan/PressReleases/ParkwayTrees.html>.

¹¹⁸ Ibid.

A second incentive available to Austin developers when working on a preferable project is expedited permitting. In contrast to that, the City places “corresponding greater scrutiny for projects...in sensitive environmental zones” (Beatley 72).

Austin also has a Yellow Bike Project community organization that functions similar to the Madison Red Bike Project. This program has placed over 600 bikes on city streets for free use.

Relevance to Seattle: As an alternative to, or instead of, the fee and incentive systems proposed above, Seattle could create a point system and a similar system of fee reduction/elimination based upon a developer attaining a certain number of points. Indeed, the Master Builders Association of King and Snohomish Counties already has a program, the Built Green program, that codifies a system points for building developments. Points are available for a number of green features, of which one is water management. Though this program is intended for buildings and not infrastructure, it could be adapted for streets. Further, while the points awarded in the Built Green program currently are not tied to permitting and fees, they do create a framework upon which such a program could be built.¹¹⁹ Concurrently, the City could place additional delay hurdles on development not meeting preferred standards.

EAST

Boston, MA

Though a much older city than Seattle, Boston has some innovations worth noting, particularly in terms of stormwater mitigation and greenspace.

Stormwater Mitigation: The Parks Department is currently testing the use of structural soils under sidewalks and in tree wells. These soils are aggregate planting soils developed by Cornell University, and are supportive enough to be driven over yet remain porous enough to support tree roots and water infiltration. The soil mix varies by location.

Greenscapes: Boston places significant value on its street trees, which results in impressive retention of older trees and incentives for planting of new trees. Street trees are planted twice a year by the Parks Department, which also assigns street trees a monetary value. Massachusetts law requires public hearings for the removal of any healthy trees in Boston, making removal of trees extremely difficult unless they are dead or diseased. Further, as developers prefer not to appear in public hearings seeking the right to remove trees, most developers only propose the removal of dead or dying trees.

Should a developer wish to remove a healthy tree, however, the developer has two options: replant trees of an equal value (which, in the case of a large, older tree, can be significant), or make a donation to the Parks Department’s nonprofit, which uses the money to purchase and plant more trees. After making their donation or agreeing to additional plantings, the developer then still has to work with the Public Works, Lighting, Water and Sewer, and Parks Departments, all of whom must review the developer’s plans and then meet for a joint meeting, at which

¹¹⁹ More on the Built Green program, including a description of green building design features and associated points, can be found on <http://www.builtgreen.net/index.html>.

acceptance details are determined, according to the Parks Department's Georgia Silvera Seamans.¹²⁰ This again creates a disincentive for the removal of living trees. Further, Silvera Seamans noted, many developers are recognizing that property owners and residents desire trees and are including trees themselves; accordingly, the City generally finds it does not have to create incentives for tree plantings.

Relevance to Seattle: Placing – and enforcing – a value on trees could create a strong incentive for residents and developers to better care for Seattle's urban forest. Regulations currently exist regarding residents' obligations to street trees, but more could be done to codify the value of those trees, and stronger enforcement of existing (and potentially new) regulations could be valuable. As in Boston, it is crucial that regulations are both strong and flexible, and that residents and developers are aware of those regulations.

Brookline, MA

The City of Brookline, a suburb of Boston, has been experimenting with landscaped curb extensions, primarily as a way to get drivers to reduce their speed, and has installed one woonerf to date. The woonerf was the product of collaboration with the development of a major hotel, and accordingly presents a relatively unique situation. However, it does serve as an example of a city's use of its permitting power to encourage forward-thinking design.

The woonerf development came about as a result of a request to build a large hotel at a relatively busy intersection in Brookline. Neighborhood groups opposed the development, and the corporation undertaking the development sought green alternatives to make the development more appealing. The street had been a cut-through with relatively high-speed traffic, and the hotel realized that development of a woonerf would (and did) slow traffic. The hotel paid for the development, shown at right, which includes a small park and a chicane, and both the City and the neighborhood residents consented to the hotel development.

Transportation and Engineering Director Peter Ditto noted that further initial skepticism came from the City's Department of Public Works, who worried they would have difficulty plowing the unusual street configuration. He also said, however, that with one winter now past, the Department seems able to manage it.¹²¹



Brookline has also experimented with planters, bulbouts and pervious pavers. The City has been hesitant to implement many of the new innovations, including the woonerf, wishing to avoid unnecessary dissatisfaction of residents or developers. To assuage some of those concerns, the City has in numerous circumstances hired outside engineers for third-party review of proposed design changes. Interestingly, since commencing installation of traffic calming devices, the City has been inundated with requests for more – often in places whose traffic flow does not merit traffic calming – which seems to indicate again the desirability of many of these innovations.

¹²⁰ Phone interview with Georgia Silvera Seamans on 17 Mar 2004.

¹²¹ Phone interview with Peter Ditto on 3 Mar 2004.

Relevance to Seattle: Brookline made good use of the strong desires of a developer with substantial resources to develop new, innovative designs for the public good. In this way, minimal public funds were used (only on some small paving elements), but the City attained a traffic-calmed, pedestrian-friendly area with a small park and greenery. Seattle could, and should, emulate this process with developers wishing to undertake politically sensitive development. As discussed in Chicago's *Relevance* section, numerous opportunities exist.

TORONTO, ON

Toronto has developed one of the more innovative methods to be found for managing stormwater runoff. The city uses a fairly traditional series of retention ponds that are always available to hold water and that allow pollution in the form of suspended solids to settle over an extended detention period. However, they have also constructed a series of parks that, in wet conditions, can have their sewer entry points can be closed off to cause an accumulation of excess runoff water, effectively turning the public parks into detention ponds. These "on-demand" retention ponds provide additional capacity for excess rainwater collection as needed, while concurrently serving the City's greater demands for parks in dry times.¹²²

Relevance to Seattle: Though quite different to anything else yet contemplated, it would be useful for Seattle to consider this multiple use potential with the development of any new parks, and the redevelopment of older parks. Though major storm events are generally relatively rare in Seattle, if they prove financially low-risk, the combination parks/detention ponds could prove useful. Further, as with SEA Street, development of such parks could prove educational for the City, and it could use lessons learned from such a development in future projects.

¹²² It should be noted, as Toronto points out, that the park detention ponds must have adequate signage, as well as an alarm system that is activated at the start of the closing process, to ensure that people leave them during storms. In construction of these detention ponds, each water entrance point is equipped with a rock structure to dissipate the water, with the whole area having a gradual slope down toward the center of the pond. This information retrieved on 16 Feb 2004 from Toronto's "Protecting water quality – Stormwater management" website: http://www.city.toronto.on.ca/water/protecting_quality/stormwater_management/ponds.htm

INTERNATIONAL EXAMPLES OF SUSTAINABLE STREET DESIGN

This section will focus on some examples derived from research on cities outside of North America. These cities all lead on some element, or many, of sustainable street design. Though the social contracts are different as one moves around the world, some lessons can still be learned.

CHRISTCHURCH, NEW ZEALAND

Christchurch has been working with a concept similar to woonerven, which they have termed “living streets,” since 1999. The City Council “stumbled upon the...philosophy” quite by accident, according to Paul Burden, Area Engineer for the Christchurch City Council, as they sought to understand the increasing popularity of traffic calming devices.¹²³ They realized, upon study, that more than simply slowing traffic, which was one component, people were seeking “preservation or enhancement of quality of life,” particularly in the street environment.

With the realization of residential demands, the City Council moved to improve communication and understanding of the desires of residents for their roads. Through this, they came upon the notion of living streets, the central tenet of which is that streets should, by design, be first and foremost a place of “living and community interaction.” Living streets strive to replace cars with people as the focus of streets, which will encourage better driving and create “a safer and more desirable environment for residents, businesses, pedestrians and cyclists.”¹²⁴ While Christchurch is quick to emphasize that automobiles are not excluded from living streets, their intent is to create a living city in which roads not only serve as transit corridors but also “encourage a better quality of life and a greater range of community and street activity.”¹²⁵

The Christchurch plan does not fail to take into account the economic effects of creating more pedestrian-centric roads. Indeed, the New Zealand National Pedestrian Project notes that the creation of “walkable road environments” is quite cost effective when compared against other transportation investments, with creation of safe and enjoyable road environments achievable for “less than the cost of building a single kilometer of motorway.”¹²⁶ The Project goes on to point out that these streets will benefit residents of the community, making it more bicycle and public transit-friendly and reducing vehicle speed, which it labels as a significant contributing factor to many urban road crashes.¹²⁷

An interview regarding the Living Streets program with Burden provided an in-depth glimpse into the process of living street development in Christchurch. To begin, Burden noted that the overall experience of working to develop living streets and incorporate them into City planning

¹²³ Email interview with Paul Burden, Area Engineer for the Christchurch City Council, 22 Mar 2004.

¹²⁴ Retrieved on 8 Feb 2004 from the website of the City of Christchurch, New Zealand:

<http://www.ccc.govt.nz/livingstreets/>.

¹²⁵ Retrieved on 18 Feb 2004 from the website of Christchurch, New Zealand: <http://www.ccc.govt.nz/livingstreets/>.

¹²⁶ As determined from cost estimates based on engineering and other treatments, provided by Waitakere City, Transit New Zealand, and LTSA. “New Zealand Pedestrian Profile: An Overview of Pedestrian Activity & Injury in New Zealand.” National Pedestrian Project, Nov 2000. Page 16.

¹²⁷ “New Zealand Pedestrian Profile: An Overview of Pedestrian Activity & Injury in New Zealand.” National Pedestrian Project, Nov 2000. Page 16.

has been a positive one. It has also been a demonstration of civic leadership, with Burden noting that, “the (Christchurch City) Council has a responsibility to lead change.” Unsurprisingly, change in Christchurch has not been easy: the culture, he feels, in most communities and planning departments still gives automatic priority to the automobile.

Further to that, Burden cited “different attitudes and policies relating to the use and function of road space” as being one of the biggest challenges to instituting changes of this nature, noting that strong differences exist not only between organizations but also within different departments in the same organization. However, he also commented that change is happening, slowly, with increasing numbers of people recognizing that roads are unique areas of public space akin to the town square, not necessarily giving automatic priority to any particular use of a space but rather encouraging various uses to compete for and justify its place within that space. To that end, he spoke of his work trying to get traffic engineers to work with landscape architects, urban designers, planners, and other people interested in the space – to ensure the full spectrum of opinions and needs are taken into account.

To date, all living streets projects have been funded by the City Council. However, private property owners have, in Burden’s experience, been willing to contribute to the projects if given the opportunity. When constructing living streets, Christchurch goes to considerable lengths to incorporate local communities in the design and development process, something Burden believes key to the success of the program. Finally, while the City plans to continue developing streets on the living streets model, Burden says that the City hopes to imbue the philosophies of living streets into their business as usual, eventually dropping the need for an extra name.

Relevance to Seattle: Again, public process and recognition of the desires and requirements of multiple departments as well as citizens appears to have been key to the process of sustainable street design. Further, intradepartmental and interdepartmental collaboration is seen as key. The importance of departmental agreement on such broad new initiatives continues to arise, as noted above in various other cities, and the Christchurch program seems to be a particularly successful example of numerous governmental bodies working together to accomplish bold new programs. Though still not easy, Christchurch seems to have made good use of meetings to attain interdisciplinary buy-in and interest – a key Seattle would do well to duplicate as some departments proceed with projects about which other departments are less certain.

EUROPE

Copenhagen, Denmark

The city of Copenhagen, Denmark, is a strong proponent of bicycling. The City offers a program called “City Bike” that is similar to Madison’s Red Bikes Project and the Austin Yellow Bike Project. However, in this case the City is the driving force behind the program, and has invested over \$175,000¹²⁸ in the purchase and provision of 2,000 free bicycles scattered around 110 different locations in the central city area.¹²⁹ The bikes can be used for a deposit of approximately \$3, which is returned when the bike is returned to another rack. The City offers

¹²⁸ Retrieved on 5 May 2004 from Wonderful Copenhagen: <http://www.visitcopenhagen.dk/composite-425.htm>

¹²⁹ Email interview with Christian Christensen, City Bike Copenhagen coordinator. 16 May 2004.

bicycles between May and December. The City undertakes maintenance via both rolling bicycle repairs shops and a central repair shop. Rehabilitates from a center for the disabled perform much of the repair work.

Christian Christensen, the City Bike Copenhagen coordinator, reports that, the program is a success. To ensure bicycles stay in the city, fines of around \$150 can be imposed upon people found riding outside of the city. Christensen acknowledges that too many bikes were stolen last year, but he also noted that many of them were returned, in particular following news reports about the problem. The program, Christensen stated, began in 1995 and is now completely supported by sponsors (including Coke and Pepsi, as well as the British Government), as well as being approved by the City Council. Sponsors receive advertising on the bicycles and bike stations, including on the wheels of the bicycles.

Market research has shown that 55% of all Danish residents are aware of the City Bike program, with 29% having seen advertisements, and an even more impressive 96% of Copenhagen residents are aware of City Bike (with 71% having seen the advertisements).¹³⁰ These numbers demonstrate an impressive pervasiveness of this program, particularly in a time when fresh advertising space is increasingly difficult to attain.

Relevance to Seattle: Copenhagen, Madison and Austin have all developed different examples of a free bike or bikesharing program, all with relative merits. Seattle would do well to implement a bicycle-sharing program, perhaps along the lines of the Flexcar program, and could choose from the public or non-profit avenues for this new program. Should the City choose to be proprietor of a bikesharing program, it could collaborate with local nonprofits such as Bike Works, a local nonprofit that trains youth in bike repair while providing bikes and bicycle services to the community. Alternately, should the City prefer to let the nonprofit sector accomplish such a program, it could work with various groups (again, starting perhaps with Bike Works) to develop such a program.

In addition, as noted in the Minneapolis section, the City could work with property developers to locate bicycle stations in buildings, providing options for urban dwellers. Financing could be attained partly or completely through sponsorship, a situation that would both mitigate potential losses from theft and reduce both start-up and operating costs in the long-term. The City, in essence, could create the program and then step back and serve merely as manager.

Netherlands

As home of the woonerven street concept, the Netherlands is rightfully an oft-cited example of the pedestrian and bicycle orientation aspect of sustainable street design and, by extension, the green spaces element. Woonerven are, however, a relatively new concept, even in the Netherlands: they first appeared in the mid-1970s. Their adoption in the Netherlands, though, has been swift: it is estimated that as of 1999, the country (which is just less than twice the size of New Jersey¹³¹) had 6,000 woonerven streets.

¹³⁰ Retrieved on 5 May 2004 from City Bike: <http://www.bycyklen.dk/engelsk/annoncor-info/antal.html>.

¹³¹ CIA World Factbook. Retrieved on 1 May 2004 from <http://www.cia.gov/cia/publications/factbook/geos/nl.html>.

In the Netherlands, conversion of normal streets to woonerven requires approval by 60% of the neighborhood residents, and the combination of this high level of buy-in needed to build woonerven with the relatively large number of woonerven imply that the concept is both popular and functional. Interestingly, streets in the Netherlands must meet certain conditions to be called woonerven, and upon being designated as such, have a different legal relationship between cars, pedestrians and bicyclists. On woonerven, as compared to conventional streets where cars have rights-of-way over slower moving traffic, all modes of transportation are considered equal (Beatley 142). With a plethora of streets already in place, the Netherlands shows no signs of slowing in the construction of woonerven, showing the exciting possibilities of the future.

Amsterdam, Netherlands

Amsterdam is a model of the bicycle-orientation element of sustainable street design. This city of 735,000 people¹³² in northern Europe boldly claims to be the bicycle capital of Europe, welcoming potential visitors while in the same breath urging that they be aware of what they are getting into if entering Amsterdam by car: “Traffic jams, getting stuck, and a testing of your patience.”¹³³ The City has developed a series of aggressive parking policies, including restricting parking spaces and encouraging high-traffic development, such as office complexes, near transit stops. New businesses are allotted a limited number of parking spaces, with the number of spaces available reduced as the businesses are located closer to transit hubs. Amsterdam also has relatively high hourly parking fees, and is known for using a boot on the cars of parking violators.

The city of Amsterdam, it can be said, strongly encourages bicycle use. Indeed, according to the City’s website, “bicycle is the ideal mode of transport,”¹³⁴ a factor doubtless partly responsible for the fact that 25% of the city’s transportation (and 40% in the city center) takes place by bicycle.¹³⁵ However, beyond simply encouraging it vocally, the City has made, and continues to make, strong efforts at encouraging and facilitating bicycle and pedestrian transportation. To begin, Amsterdam has specifically created an unambiguous bicycle policy designed to “transform the bicycle into a fully-fledged mode of transport” to rival the private auto. The City recognizes that part of accomplishing that will mean the development and maintenance of good bicycle routes, “adequately planned intersections” and sufficient bicycle parking facilities. The central district includes a number of car-free areas, and the rest of the city caters to pedestrian and bicycle traffic.

Amsterdam also provides an online resource kit for cyclists, including a map of the city¹³⁶ that is regularly updated with traffic advisories for bicyclists. According to The Amsterdam Bicycle Policy, the City has also developed two trials of a concept similar to Park and Ride facilities, called Park and Bike facilities. People can drive to the Park and Bike locations, and then rent a

¹³² Per the 2000 census, retrieved on 17 Mar 2004 from the City of Amsterdam website:

<http://www.amsterdam.nl/asp/get.asp?ItmIdt=00000498&SitIdt=00000005&VarIdt=00000002#&popup=normal>

¹³³ Ibid.

¹³⁴ Retrieved from Amsterdam’s website on 1 May 2004: <http://www.bereikbaaramsterdam.nl/english/fiets01.htm>

¹³⁵ “The Amsterdam Bicycle Policy.” Gemeente Amsterdam: dienst Infrastructuur Verkeer en Vervoer. Jul 2003. Retrieved on 1 May 2004 from http://www.ivv.amsterdam.nl/fiets/pdf/Amsterdam_bicycle_policy.pdf.

¹³⁶ The map allows a user to select a particular segment of Amsterdam. The map that arises includes construction hotspots and route-planning assistance. The maps can be found at <http://www.werkaandeweg.amsterdam.nl/divs>.

bicycle. The City has also installed a network of guarded bicycle sheds throughout Amsterdam in efforts to reduce the likelihood and occurrence of bicycle theft. A photo of one of these sheds, called Locker, is at the right.



Amsterdam also encourages walking, though without the ferocity and dedication used on bicycling.

Relevance to Seattle: Education and development of infrastructure have been key components of Amsterdam’s move toward increased bicycle and pedestrian orientation, particularly with the woonerven concept. As noted above, one of the main barriers to increased woonerf development is public uncertainty; this can only be mitigated through education regarding the benefits of woonerven and demonstration projects that provide living examples of their viability and desirability. George Liebman, however, makes an excellent point on the transferability of the woonerf concept to American streets: “If woonerven are to be accepted in the United States, they must be presented as an expansion of the legal rights of property owners.”¹³⁷ Liebman goes on to suggest ways for doing this, including making their development contingent on neighborhood initiative, allowing their creation by “residential community associations,” or seeing them developed through street privatization, as has already been accomplished in St. Louis.

Woonerf development may be particularly attainable in newly redeveloping sections of Seattle, such as South Lake Union or the Waterfront. Though definitely downtown streets, the arterials in these sections could be redeveloped as woonerven in efforts to make them more pedestrian and bike friendly, as well as adding key elements of greenscape and stormwater mitigation. As with so many examples earlier in this paper, the City could utilize regulatory incentives such as FAR credits or height exemptions to stimulate development of woonerven or similar streets.

Utrecht, Netherlands

Utrecht is currently in planning phases for large-scale redevelopment its city center, and as such offers a good example of an undertaking similar to what Seattle might soon see. The City has begun the process of selecting a vision for the downtown area, though it is still relatively broad. To date, the City has held a referendum in which residents were to choose between two master visions. In this May 2002 referendum, according to Lucas Stalman of Utrecht’s Communication Projectorganisation Stationarea, it was determined that people wanted a greener downtown. Specifically, Stalman said, the choice selected was the one that offered a more spacious vision of the downtown, with green public areas and “wide and green” bicycle and pedestrian paths, beating out a plan with far more commercial options and more dense commercial buildings.¹³⁸

As the redevelopment progresses, Stalman said, the City intends to hold design charrettes to determine exactly what people desire. Indeed, the entire process seems built around the notion of public involvement of all phases and aspects.

¹³⁷ Liebman, George W. “Three good community-building ideas from abroad.” *The American Enterprise*. Washington. Nov-Dec 1996. P. 72.

¹³⁸ Email interview with Lucas Stalman, Communication Projectorganisation Stationarea, City of Utrecht. 17 May 2004.

Relevance to Seattle: Seattle has a fairly inclusive design process, as noted above. Further, education would be key to valuable citizen input into any large-scale redevelopment. To this end, as discussed previously in this paper, Seattle should make all efforts to educate the public about the benefits of all sustainable street design elements. Following these efforts, public opinion could be sought and expected, and would likely provide valuable insights into the best development and redevelopment strategies for specific areas.

Malmö, Sweden

The City of Malmö determined to create an official policy to sustainably manage stormwater. In this case, the City's Water and Wastewater department worked with other technical departments to create a policy that now forms the base for the interdepartmental co-operation.¹³⁹ Interestingly, Malmö reports that the techniques and technologies necessary for sustainable stormwater are already extant and well established. Rather, implementation of sustainable stormwater management practices have been more a problem of "co-operation between different departments in the City administration," a situation that took years of work for Malmö to overcome. It was only upon realizing the multiple needs of a street planning process – the variety of stakeholders – that Malmö was able to see that, "Drainage engineers alone can not accomplish a project where open stormwater solutions are applied. For a successful result an integrated approach is necessary, involving also the expertise of geo-hydrologists, city planners, landscape architects...(and) the inhabitants in the area" (Stahre 235). In essence, an important key to sustainable stormwater management learned by Malmö is that "co-operation between different departments in the City administration is of greatest importance."

Relevance to Seattle: Malmö's experience should be looked at as Seattle's experience, five or ten years from now. Malmö understands interdepartmental coordination and collaboration to be an integral part of sustainable street design. It seems likely that this interdisciplinary focus will continue to be acknowledged as the basis, not only of sustainable street design, but also of a more holistic approach to urban design practices in general.

Erlangen, Germany

The city of Erlangen has taken bold steps to integrate bicycle- and pedestrian-orientation into the entire city. Rather than simply focus on creating bike paths, the City focuses transportation planning efforts on protecting, and even privileging, bicycle users at all steps in the process through both infrastructure and policy. The City has developed level, clearly marked bike paths, given bicycles precedent at traffic lights, and has been touting the city's traffic congestion and relative ease of navigation by non-auto means as incentive for people to reject motorized transport. Of particular note, Erlangen has placed the creation of a bicycle friendly climate at the heart of its transportation plan, calling for "all reasonable means" to be tried in efforts to shift residents towards more use of public transportation, walking and cycling."¹⁴⁰ The goal of the

¹³⁹ Stahre, Dr. Ingr. Peter. "Recent Experiences in the Use of BMPs in Malmö, Sweden." Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation, edited by Ben R. Urbonas. American Society of Civil Engineers, 2002. P. 226-227.

¹⁴⁰ Retrieved on 21 Mar 2004 from The International Council for Local Environmental Initiatives (ICLEI) website: <http://www3.iclei.org/egpis/egpc-024.html>.

City, rather than maintaining a car-oriented city in which one can bike, is to make the overall climate of the city bicycle-oriented to the extent that extra bike paths need be built only in situations of unusually heavy, fast motorized traffic. To accomplish that goal, the City regularly attaches bicycle orientation to other transportation projects, ensuring that bicycling and pedestrianism are considered in all road development.

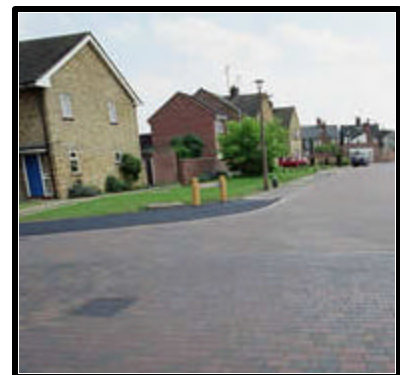
Relevance to Seattle: Seattle is making strides towards becoming a bike- and pedestrian-oriented city. However, as with the recommendations in the Portland section, Seattle should make all efforts to ensure that pedestrian- and bike-orientation are considered in all transportation and road decisions. The City should ensure the needs of bicyclists and pedestrians are considered in tandem with the needs of auto-based traffic on all developments.

United Kingdom

The United Kingdom (UK) is currently working to bolster both the practice and public relations aspects of its various sustainable-oriented programs, and sustainable street design techniques are among those gaining steam. Though no city stands out, the Country is taking notable steps.

Bicycle and Pedestrian Orientation: The British have adopted the woonerven idea, relabeling them “Home Zones,” as a way to make neighborhood streets safer for children.¹⁴¹ Indeed, home zones are defined as streets or groups of streets that have been designed “primarily to meet the interests of pedestrians and cyclists rather than motorists.”¹⁴² Home zones give priority to neither autos nor non-motorized traffic, but introduce instead features making the street more accessible for pedestrians. These zones are being accomplished on both redevelopments and new projects, and are undertaken by the Department for Transport Local Government and the Regions (DTLR) as well as with the Department of Transportation. The home zones use traffic calming measures, reduced traffic speeds, and clear signage to inform drivers that the streets are “places for people, not just for traffic.”¹⁴³ In addition, the national Transport Act 2000 gives local authorities power to designate local roads as home zones, as well as granting power to enact regulations or speed limits to enable creation of home zones.

Home zones, of which one is pictured at right, are credited with community building, perhaps not surprising given Seattle’s experiences on SEA Street and similar projects. However, like Portland’s proposed new green street development, home zone projects are now being instituted in Britain in a number of low-income, neglected areas. Many of these areas have high levels of unemployment and low percentages of car ownership, and the intent seems to be development of a sense of community that, in turn, instills a sense of community pride and purpose. Though too new to know the outcome, home zones may yield economic and social benefits as well as improvement of the urban form in these low-income areas.



¹⁴¹ Beatley. P. 143.

¹⁴² Retrieved on 30 May 2004 from the Home Zones website, National Children’s Bureau:
<http://www.homezonenews.org.uk/intro/index.asp>.

¹⁴³ Ibid.

Private Development: Private developers are often seen as uninterested in sustainable design measures. However, as a number of private entities in the United Kingdom (as well as in Seattle and countless other places) are discovering, sustainable street design methods can be incorporated for a number of benefits. One such development that has successfully developed a sustainably designed streetscape is Wessex Water Ltd Operations Centre, in Bath, England. This development has a good deal in common with Seattle development conditions, in particular with the South Lake Union area currently being considered for redevelopment.

At £22 million,¹⁴⁴ the Wessex Operations Centre is a large-scale development that incorporates office buildings, an operations center, parking facility, roads and landscaped areas, with approximately 1.5ha of the 2ha¹⁴⁵ site covered in pervious surfaces (either roofed or paved). In its redevelopment, it has utilized permeable paving in car parking areas, including concrete blocks and grass pavers for areas of greater and less auto use, respectively. In addition, porous blocks were used to carry water to soakways¹⁴⁶ and swales drain into storage tanks for both greywater storage and emergency overflow capacity. The stored water, in turn, is pumped out to water ornamental landscaping and for use in toilets.

Wessex reported a number of considerations that served as both incentives and disincentives for their sustainability-oriented development. These are laid out in the graph below.¹⁴⁷

Benefits to sustainable design features	Challenges
The public relations benefit to being seen as green. Promoting sustainable drainage is good PR.	Technical difficulties; concerns about potential infiltration problems were overcome by consultation and design flexibility.
Reduced surface flows to sewer system. All stormwater runoff can be contained on-site.	Cost. Traditional drainage would have been cheaper to install, but Wessex wanted more sustainable systems.
Ease of integration into landscape. Swales and grass pavers are part of and add to the landscaping.	

Similarly, a vast business park development in Bristol has been the site of a number of sustainable street design techniques. Built on 11.6 Ha¹⁴⁸ of land, the site sits on a hill and incorporates permeable paving, a detention pond, and swales. The graph below lists a couple of challenges as well as benefits of the business park's sustainable street design features.

¹⁴⁴ Approximately \$40,306,200, as converted on 27 May 2004 on <http://www.xe.com/>.

¹⁴⁵ Approximately 3.7 acre to 4.9 acre, as converted on 27 May 2004 on <http://convert.french-property.co.uk/>.

¹⁴⁶ Soakways are subsurface structures that aid in the infiltration of surface water. Retrieved on 25 Apr 2004 from the CIRIA website: <http://www.ciria.org.uk/suds/glossary.htm#soakaway>.

¹⁴⁷ Retrieved on 25 Apr 2004 from the CIRIA homepage: http://www.ciria.org.uk/suds/cs_wessex_water_op_centre.htm.

¹⁴⁸ Approximately 28.7 acres as converted on 27 May 2004 on <http://convert.french-property.co.uk/>.

BRISTOL BUSINESS PARK, BRISTOL, United Kingdom	
Benefits to sustainable design features	Challenges
Permeable paving reduces land needed for detention ponds – saving money.	Permeable paving required early installation of services and drainage.
Permeable paving & swales satisfied local sustainability policy.	More care needed to avoid contamination of system at all stages, especially from sand & topsoil.

Relevance to Seattle: The United Kingdom’s adoption of Home Zones and their subsequent development across the country stands as testament to the desirability of more walkable, pedestrian- and bike-friendly communities. As noted above, Seattle has made significant steps in this direction. Worthy of consideration from the British example, however, is the creation of home zones particularly in low-income neighborhoods. As discussed, it is too early to know how these street designs will affect community interaction, but it seems entirely possible that the rise in pride that will accompany a more community-oriented, attractive streetscape could well lead to an overall improvement in life circumstances for many of the residents of such areas. Seattle would do well to consider further development of sustainably designed streets in low-income areas, as it will be doing in the Highpoint development.

In addition, it is useful for Seattle to note that private development of sustainably designed street elements is occurring in the United Kingdom for many of the same reasons as it has occurred here: perceived marketability of green features, reduction of costs associated with stormwater treatment, and overall aesthetic benefits. The City should take advantage of this knowledge when encouraging and advocating for the private development of sustainably designed streets or elements of the same, playing to both the economic and social bottom lines of area developers.

CURITIBA, BRASIL

The city of Curitiba, Brasil, is often referred to as the “ecological capital of Brasil,”¹⁴⁹ replete with 28 parks and forest areas representing a total of 20% of the city’s land and equaling out to 52 square meters of green space per resident – dramatic growth since the 1970 figure of only one square meter per resident. The dramatic increase in greenery in Curitiba was largely the result of a substantial restructuring of the government. In the 1970s, the City merged the transit departments with the land-use planning departments, allowing the City to reduce its investment and commitment to auto-based transportation while offering more pedestrian and recreational areas in the city center. It also stimulated the use of public transportation and bicycling, an accomplishment partially accomplished by the creation of 200 kilometers of bicycle paths.

An additional measure crucial in developing the green nature of Curitiba was the creation of a program of tax incentives for developers contemplating green areas. Through government coordination and developer initiative, the center of the city saw development of myriad pedestrian-only roads, including a 24-hour commercial center replete with cafes and restaurants. According to City estimates, this “vibrant pedestrian zone” attracts tourism that, in 1994 is thought to have generated approximately US\$280 million, or four percent of the city’s net

¹⁴⁹ “Orientación de la Planificación Urbana para la Sostenibilidad en Curitiba, Brasil.” Retrieved on 25 Apr 2004 from <http://www3.iclei.org/localstrategies/summary/port/curitiba.html>.

revenue.¹⁵⁰ In addition, the City utilizes a series of tax incentives for development of private woodlands and gardens, a policy that has seen creation of over 1100 private woodlands and over four square miles of private green space.

Curitiba has also enacted regulations to assure greenery. It has a five-yard setback requirement applicable to all new buildings, with the space intended for residential gardens. Residential construction is limited to 50% of a site's area, and impervious paving is banned on a property's open space. The City also prohibits cutting of trees, on public or private land, and requires the planting of two trees for each one removed.¹⁵¹ Curitiba has also protected a large percentage of public greenspaces, as noted above, and has seen a dramatic increase in city wildlife.

Relevance to Seattle: It is unlikely that Seattle will merge SDOT with the DPD in the near future, but again the picture of a coherent, unified strategy rings clear in much of Curitiba's success. Curitiba has had numerous other innovative policies, including the tax incentives for creation of green spaces and the closure of some downtown streets and subsequent conversion into pedestrian-only zones. Those, too, would be a difficult political sell in Seattle, but merit some consideration. Essentially the logical extension of woonerven, pedestrian-only streets can make use of all sustainable street design techniques while creating and stimulating urban shopping centers that can compete with extra-city malls for consumer spending. Should Seattle be amenable to such areas, their creation would be relatively simple in newly redeveloping areas, and could be partly financed by groups of local property owners (who would benefit more from the higher rents possible in a pedestrian-only area).

¹⁵⁰ "Orientación de la Planificación Urbana para la Sostenibilidad en Curitiba, Brasil." Retrieved on 25 Apr 2004 from <http://www3.iclei.org/localstrategies/summary/port/curitiba.html>.

¹⁵¹ Lovins, et al. Natural Capitalism

RECOMMENDATIONS

The examples discussed above provide a template for improvements to Seattle's green streets policy, or indeed to its replacement by a more comprehensive, up-to-date sustainable street design policy. Some of the key elements that should be considered in any revised or new policy include:

- A focus on cross-agency collaboration in all phases of policy development implementation;
- Creation of policy elements that are defined enough to offer definitive guidelines to both developers and City officials, yet flexible enough to react to context;
- Continued communication and inter-City development of involved parties among whom to share successes, challenges, and ongoing ideas;
- Tax incentives for development of sustainable street design techniques such as permeable paving, bioswales, woonerven, etc;
- Creation of regulations requiring construction of bicycle facilities in all new building developments and redevelopments;
- Inclusion of sustainable street design elements into all elements of City planning and development, as opposed to an additional set of items that can be considered;
- Consideration of development of dedicated stormwater mitigation utility fund based on impervious surface area and to be spent on stormwater mitigation projects and related (including continuing innovation);
- Continued and expanded educational efforts designed to increase public demand for sustainable street design elements; and
- Continued public involvement in as much as possible of the sustainable street design process.

Development and adherence to the above recommendations should ensure a robust Seattle sustainable street design policy, and should lead to ongoing quality-of-life improvements as well as a reduction in stormwater- and auto-related infrastructure costs.

CONCLUSION

At the completion of this study, a number of potential improvements to the Seattle green streets policy rise to the fore, as well as potential improvements for the process through which developers and City officials must traverse to design and build sustainably-designed streets.

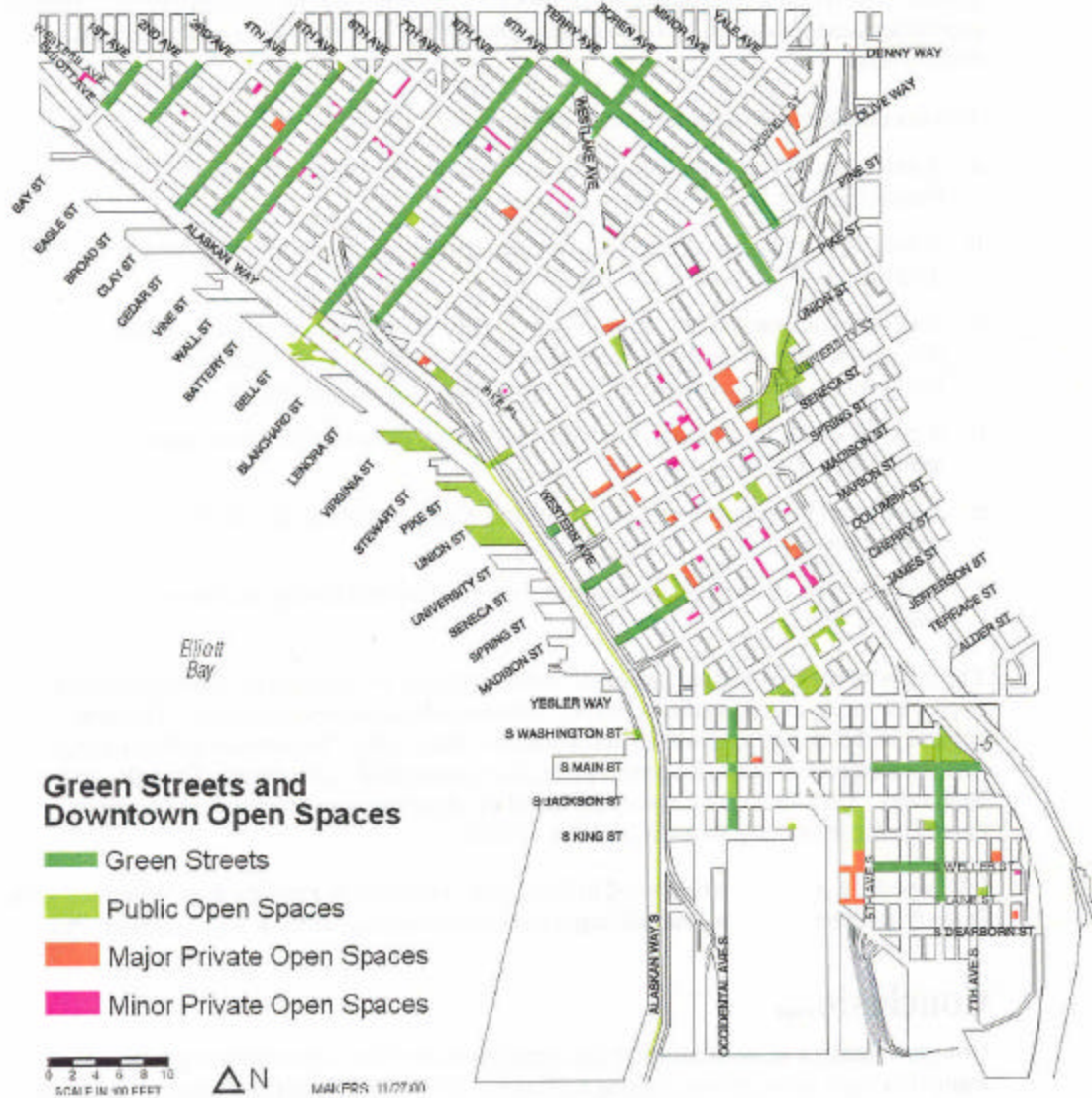
First and foremost, it would be useful to undertake training for City officials (elected officials, key policymakers, department heads/leads) on the basics of sustainable street design: what it means, why it is a good thing, how it can be accomplished, as well as a description of leading examples and BMPs from other cities. This training could be undertaken, for example, by a combination of officials from the SPU and SDOT departments, two City agencies with considerable expertise in sustainable street design, as described above. Alternately, a forum on sustainable street design was recently held that brought together representatives of Portland, Seattle and Vancouver. Some of the key leaders involved in this forum could reconvene to undertake a training campaign that could, in turn, be used to educate not only Seattle leaders but also those in Portland and Vancouver.

Second, it has become apparent through the successes and failures in both Seattle and elsewhere that collaborative, interagency definition of sustainable street design and codification of the same into City design codes is a key component to accomplishing sustainable street design. To this end, it would seem necessary to update the DCLU Director's Rule, perhaps as an effort of multiple agencies (including SPU, SDOT, DCLU, Parks, and any other department with an involvement in street design). Collaboration would reduce and hopefully eventually eliminate the discrepancies in approach between departments, creating a unified, consistent, commonly understood code that would encourage sustainable street design by both public and private entities.

Finally, continual innovation seems key in the pursuit of sustainable street design. No one has yet developed the perfect formula for sustainably designing streets; Seattle is undoubtedly on the vanguard of this new wave of envisioning the urban form, and is to be commended for its efforts. However, in no way should it be perceived that the final design has been arrived at; rather, the City should continue to allow for and encourage innovation in its departments as they seek better ways to accomplish their missions.

APPENDIX A: PROGRAM MATRIX

APPENDIX B: CURRENT SEATTLE GREEN STREET DESIGNATION



APPENDIX C: SEATTLE SSD COST MATRIX

APPENDIX D: SUSTAINABLE STREETS COSTS MATRIX

APPENDIX E: ALTERNATIVE PAVING MATERIALS¹⁵²

Paving Alternative	Details	Costs
Porous Concrete	Technology relatively well understood & widely used (FL, CA). Being promoted actively by American Concrete Institute (http://www.aci-int.net) & by WA Aggregates & Concrete Assoc (www.washingtonconcrete.org). Concrete is mixed w/o usual fine aggregate, leaving only larger aggregate & creating 15-20% voids through which stormwater can infiltrate. Designed to promote treatment of potentially contaminated stormwater before introduction into ground, so pavement reduces stormwater run-off quantity & increases quality. Can handle most volumes & speeds of vehicular traffic.	Very nearly that of traditional concrete paving. Only additional cost is about \$15 more per yard for material (about \$80/yard vs \$65/yard in Puget Sound area) according to WA Aggregates & Concrete Assoc. Minor additional cost (23%) compared to benefits in form of directly reduced stormwater fees - several hundred \$/year/acre, potentially greater depending on SPU incentives.
Interlocking Concrete Pavers	Porous ICP are well understood & promoted. Several local projects for viewing. Distributed locally by numerous companies (e.g. Mutual Materials w/ Uni Eco-Stone product: www.mutualmaterials.com/environ/eco.html). ICP are placed on a base & shaped to provide a drainage void. Void is designed to facilitate infiltration & treatment of stormwater similar to porous concrete. Useful in moderate to low vehicular traffic areas.	Mutual Materials claims pavement can be placed for \$6-8/sf, on avg. If large enough area to install pavers mechanically, cost becomes competitive w/ concrete - ~\$3/sf.
Porous asphalt	Frequently used in parks but increasingly used to increase urban infiltration.	
Reinforced grass, grassy pavers, Geoblock	"Somewhat traditional base" w/ top course of plastic cellular confinement & reinforcement layer supporting & containing sandy soil-growing medium for grass. Looks like typical lawn area w/ occasional view of edges of plastic confinement material. Completely pervious, provides significant amounts of stormwater treatment, w/ aesthetic look & feel. Supports light to low vehicular traffic loads. Material available from several local sources including Grassy Pavers (www.rkmfg.com) and Geoblock (www.sspco.org/geoblock.html). Both products are being used locally & can be viewed.	\$2-3/sf for material plus cost of base, install, planting & maintaining, totalling ~ \$7-7.50/sf depending on quantity of area installed. Benefits in form of directly reduced stormwater fees of several hundred \$/yr/acre, potentially greater w/ SPU incentives. Real benefit is ability to design dual use space - delivery trucks @ night, outdoor cafe area in day, etc.
Crushed gravel w/ soil stabilizer	Frequently used in urban parks (Central Park in NYC, Seattle Urban Horticulture Centre). Has application to sidewalks & planting strips. W/ addition of soil stabilizer (natural binder), only top 1/4" of crushed stone is mobile. Some of pervious nature of material may be lost w/ addition of a binder, but manufacturer claims it remains porous.	4" deep on compacted soil sub-base w/ binder costs ~.30/sf using local material.
Summary: Payback on use of permeable paving well below 5 yrs, significant possibility for incentive & reduced stormwater fee.		

¹⁵² All information retrieved from the Washington Department of Energy Stormwater Management Manual for Western Washington: <http://www.ecy.wa.gov/programs/wq/stormwater/manual.html>, and from the Resource Guide for Sustainable Development in an urban environment: a Case Study in South Lake Union, Seattle, Washington. 22 Oct 2002. Prepared by UEI. Page 86.

APPENDIX F: FEATURE BENEFITS

Feature	Environmental	Economic	Social
Permeable pavement	Increased drainage; aids in natural removal/breakdown of pollutants (up to 92% of sediment, high rates for pollutants).	Prices vary; depends on multiple factors. Yields reduced stormwater treatment costs.	Enhances property values, aesthetically pleasing.
Traffic calming	Often include plantings; greenhouse gas mitigation.	Reduced accidents from slower speeds; lower road costs.	Increases ped/bike accessibility to public rights-of-way.
Swales, French drains, stormwater retention ponds	Increased drainage; creates wildlife habitat	Debatable economics; benefit of stormwater reduction likely offsets extra development costs. Higher property values near greenery.	Increased neighborhood pride, aesthetic value.
Pedestrian/bike-oriented (wide sidewalks, bike lanes)	Plantings create habitat; brick stone paving is more permeable. Reduced emissions from fewer car trips.	Increased shopping; reduced expenditures on private autos = financial resources available for alternatives. Reduced health costs.	Creates community space & shared ethos; aesthetic/property values increased, improved neighborhood safety; socialization.
Woonerven	Plantings create habitat; brick, stone paving is permeable. Encourages walking/biking.	Costly, but can add economic (shopping) value to area as well as costs associated with reduced safety concerns	Creates community space & shared ethos; aesthetic/property values increased, improved neighborhood safety; socialization.
Street parks	Plantings create habitat, offer greenhouse gas mitigation. Reduce stormwater runoff.	No direct economic benefit, but increased citizen activity leads to lower crime & associated costs. Also, natural resources value.	Creates community space & shared ethos; aesthetic/property values increased, improved neighborhood safety; socialization

PHOTO/ILLUSTRATION CREDITS

Photo of Seattle chicane courtesy of SDOT website:

<http://www.ci.seattle.wa.us/transportation/ntcpprogram.htm>.

Carlson Architects sketch of Growing Vine Street project retrieved from Seattle Daily Journal of Commerce website: <http://www.djc.com/news/en/11132534.html>.

“Before” and “After” photos of SEA Street retrieved from SPU website:

<http://www.ci.seattle.wa.us/util/SEAstreets/drainage.htm>.

“Traditional” and “Conventional” diagram retrieved from the Local Government Commission website: http://www.lgc.org/community_design/street.html.

“Figure 1: Automobile Trip Lengths in the Central Puget Sound Region” retrieved from the PSRC website: <http://www.psrc.org/projects/nonmotorized/implementation/toc-ch1.pdf>.

Photo of Maplewood raingarden retrieved from the Maplewood website:

http://www.ci.maplewood.mn.us/index.asp?Type=B_BASIC&SEC={2D2425A9-BCA6-4129-AAA2-4F4CF6DBC2F5}&DE={22132A4A-DE14-48E8-B45A-25E633BB51A4}}.

“Contributors Pay Concept” graph taken from “Financing Maplewood’s Storm Water Management with a Environmental Utility” brochure, retrieved from:

<http://www.ci.maplewood.mn.us/vertical/Sites/{EBA07AA7-C8D5-43B1-A708-6F4C7A8CC374}/uploads/{0B843A98-93F5-496B-A605-FC40D93C5E47}.PDF>

Photo of Vancouver’s Country Lane retrieved from the Puget Sound Online website:

http://www.psat.wa.gov/Publications/LID_studies/permeable_pavement.htm.

Photo of Vancouver’s Centre Strip retrieved from Vancouver Engineering Services’ Environmentally Sustainable Options website:

<http://www.city.vancouver.bc.ca/engsvcs/streets/design/enviro.htm>.

Photo of Chicago’s mid-street median planter retrieved from www.chicago-l.org/stations/sox-35th.html.

Photo of the Brookline woonerf retrieved from

<http://marriott.com/property/propertyPage.mi?marshaCode=BOSBL>.

BIBLIOGRAPHY

American Forests. "Regional Ecosystem Analysis Puget Sound Metropolitan Area: Calculating the Value of Nature." Jul 1998. Retrieved from http://www.americanforests.org/downloads/rea/AF_PugetSound.pdf.

Beatley, Timothy. Green Urbanism: Learning from European Cities. Washington, DC: Island Press, 2000.

City of Chicago Departments of Environment, Planning and Development, Transportation, and Water Management. "A Guide to Stormwater Best Management Practices: Chicago's Water Agenda." Chicago, 2003.

Hawken, Paul, Lovins, Amory, and Lovins, L. Hunter. Natural Capitalism: Creating the Next Industrial Revolution. Boston: Little, Brown and Company. 1999.

Frey, Hildebrand. Designing the City: Towards a More Sustainable Urban Form. New York: E&FN Spon, 1999.

Jacobs, Jane. The Death and Life of Great American Cities. New York: Random House, 1961.

Litman, Todd. "Quantifying the Benefits of Non-Motorized Transport for Achieving TDM Objectives." Victoria Transport Policy Institute. 1 Dec 1999. Retrieved from <http://www.vtpi.org/nmt-tdm.pdf>.

Puget Sound Regional Council. "Regional Bicycle and Pedestrian Implementation Strategy for the Central Puget Sound Region." Seattle: Puget Sound Regional Council, Feb 2003.

Schneider, Keith. "Michigan's Smart Growth Governor and Her Unlikely Allies: Granholm and Republican leaders share similar values on sprawl." Great Lakes Bulletin News Service, 22 Nov 2002. Retrieved on 17 Mar 2004 from the Michigan Land Use Institute website: <http://www.mlui.org/growthmanagement/fullarticle.asp?fileid=16375>.

Studer, Noelle. "A Policy Approach to Analyzing the Problem of Low Levels of Street Tree Maintenance in Seattle's Neighborhoods." 10 December 2002.

Thayer, Kelly. "People and Pavement: New Institute report on transportation design that respects communities." Great Lakes Bulletin News Service. 5 Feb 2004. Retrieved on 17 Mar 2004 from <http://www.mlui.org/transportation/fullarticle.asp?fileid=16632>.

"The 2004 Environmental Action Agenda." Mayor Greg J. Nickels, City of Seattle. 19 Feb 2004.

Urbanas, Ben R. Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation: Proceedings of an Engineering Foundation Conference. Reston, Virginia: American Society of Civil Engineers, 2002.

All traffic calming information derived from the websites listed below:

<http://www.ci.berkeley.ca.us/transportation/TrafficCalming/diverters.html>

http://www.ddot.dc.gov/ddot/frames.asp?doc=/ddot/lib/ddot/services/pdf/draft_p1_10.pdf&open=32397

<http://www.ecocitycleveland.org/transportation/traffic/tools.html>

<http://www.fhwa.dot.gov/environment/tcalm/part2.htm>

<http://www.ite.org/traffic/tcdevices.htm>